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The Journal of HEREDITY

A monthly publication devoted to Plant Breeding Animal Breeding and Eugenics

TEOSINTE IN MEXICO
THE CELL MECHANISM
THREE NEW MUTATIONS
SELECTING HOLSTEIN-FRIESIAN SIRES
INHERITANCE OF PIT IN THE EAR
KITH AND KIN

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CONTENTS

TEOSINTE IN MEXICO.....G. N. COLLINS 339
THE CELL MECHANISM (REVIEW).....E. ELEANOR CAROTHERS 351
THE IMPROVEMENT OF CITRUS FRUITS (REVIEW)..... 353
THREE NEW MUTATIONS IN OENOTHERA LAMARCKIANA. .....GEORGE H. SHULL 354
KITH AND KIN.....ALEXANDER GRAHAM BELL 364
FOUNDATIONS OF HUMAN GENETICS (REVIEW)..... 365
INHERITANCE OF A PIT IN THE EAR.....J. E. KINDRED 366
THE TREND OF THE RACE (REVIEW)..... 367
THE CONTROL OF PARENTHOOD (REVIEW)..... 367
SELECTING HOLSTEIN-FRIESIAN SIRES FOR HIGH YEARLY PRODUCTION.....R. E. HUNT 368

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Date of issue of this number, March 18, 1922.

A WILD TEOSINTE PLANT IN CENTRAL MEXICO

In the study of the origin and history of maize or Indian corn, teosinte has, in recent years, come to play an important rôle. It is the nearest wild relative of maize yet discovered, and a possible ancestor of that species. Two types of teosinte have been found in Mexico; one annual, and the other perennial, in character. Assuming that both are descended from a common stock, it seems reasonable to believe that the perennial form most closely approximates this common ancestor. The plant here shown, which is growing beside a small irrigating canal at Anavacuyán, Durango, Mexico, is of the annual type. (Frontispiece.)

TEOSINTE IN MEXICO[1]

The closest wild relative of Maize is Teosinte—a forage plant hitherto known only as an annual. A perennial form discovered in Southern Mexico should prove of value to the breeder

G. N. COLLINS

Bureau of Plant Industry, U. S. Department of Agriculture

TEOSINTE is the Mexican name of a genus of large grasses (Euchlaena), the only wild plant that has been hybridized with maize. As at present recognized Euchlaena is considered a monotypic genus, all forms of teosinte being referred to the one species, *Euchlaena Mexicana* Schrad.

Before our recent trip to Mexico we were familiar with but two forms of teosinte; first, the teosinte listed by many American seed firms and widely grown in warm countries as a forage plant. In the United States it matures seed only in southern Florida and all the American trade is supplied with seed from a single plantation.

The origin of this type is uncertain. The Florida form appears to be the same as that distributed from France to many tropical countries, and the early records indicate that teosinte was introduced into France from Guatemala.

The form and color of the seed, as well as a number of plant characters, make it an easy matter to separate this variety, which we have called "Florida," from the second form known as "Durango," from its place of origin in the Mexican state of Durango.

The Durango variety was first brought to the United States by Dr. Edward Palmer, the veteran Mexican collector. The original introduction failed to mature seed when planted at Washington and the stock was lost.

A second lot of seed of the Durango variety was obtained from Dr. H. V. Jackson of Durango. Planted in southern California it produces an abundance of seed. So far as known Durango teosinte has not been exploited commercially, except that it was the form from which Burbank derived the variety called "Early Harvest." Dr. Jackson supplied Mr. Burbank with seed of Durango teosinte and in fact sent seed of hybrids between this and maize that may have provided the intermediate forms put forth by Mr. Burbank as demonstrating the evolution of maize from teosinte.

The Durango variety is distinctly more maizelike than "Florida," and the possibility that the distinguishing characteristics of this form might be due to admixture with maize at some remote time made it seem unwise to recognize the two forms as specifically distinct until a study could be made of the conditions under which they grow in a wild state.

Before 1910 teosinte was known only as an annual plant. In that year Dr. A. S. Hitchcock discovered in the State of Jalisco a perennial form of teosinte that propagates itself by rhizomes. All the annual types of teosinte were known to hybridize readily with maize and it was at once appreciated that new forms, of possible economic as well as of great scientific interest, would result if living plants of this perennial type could be obtained and if crosses with maize could be affected.

The unsettled conditions in Mexico made it impracticable to conduct explorations in that country until the past season. In September and October 1921, Mr. J. H. Kempton and the writer visited Mexico primarily for the purpose of procuring living plants and seeds of the perennial form and also to obtain more definite information regarding the distribution and uses of the annual types of teosinte growing in Mexico.

[1] Paper read before the Botanical Society of America, Toronto, Canada, December 28, 1921.

TEOSINTE IN DURANGO

Our first objective was the City of Durango. It was near this city that Dr. Edward Palmer had first collected seed of a teosinte distinct from that grown in the southern states and known as Florida teosinte; and it was also from this locality that Dr. H. V. Jackson had supplied us with seed of this variety since extensively used in genetic experiments and usually referred to as "Durango teosinte."

After a number of unsuccessful trips about Durango, teosinte was found growing wild along the bank of an old irrigating ditch at Alcalde Ranch, Anavacuyán, about 15 miles east of Durango. (Frontispiece.) The plants were growing amid a luxuriant growth of other plants and practically in the water. The other plants were chiefly sedges, grasses and Polygonum. While at this time there was no maize within a quarter or half mile, the locality was one in which maize had formerly been grown. The teosinte plants showed the same diversity of forms and the same evidences of remote hybridization with maize that has been observed in our plantings of Durango teosinte.

We learned that teosinte had been planted about Durango as a forage plant in an experimental way but apparently no one is now growing it. Wherever planted, it reseeds itself year after year and most people who know it consider it a weed to be eradicated and many have the idea that it will cross with maize to the detriment of the latter.

Other expeditions were made to points within ten or fifteen miles of Durango, but the only additional plants of teosinte that were found were two stunted individuals growing in the garden of a Catholic priest in Durango where they had survived from a former planting. It may be concluded that teosinte is a rather rare plant about Durango and that it is known there only as a weed.

TEOSINTE IN THE STATE OF MEXICO

From Mexico City we went by auto to the region of Lake Chalco since this region is mentioned by Lopez y Parra[2] as one in which teosinte grows.

Teosinte was found a mile or so from the town of Chalco on the road from Mexico City. It was growing along ditch banks by the side of a corn field and in barley fields. (Fig. 2.) The plants were small, the tallest not over six feet in height. The small size was due perhaps to the severe competition with other plants. Along the side of the corn field they were in the midst of other grasses, Ipomeas, and other plants. A few individuals were found also as weeds in the corn fields. In two of the barley fields in this locality teosinte was one of the most common weeds.

There were some indications that the teosinte had been hybridized with maize, but this evidence was not so pronounced as the close intermingling of the two species would lead one to expect. No teosinte characters could be detected in the maize, unless branches in the axil of the prophyllum be so considered, and this character is common to all maize of the *Zea hirta* type. The maize at Chalco had red sheaths, few tassel branches, short ear stalks, well-developed tuberculate hairs as well as branches in the axil of the prophyllum. It was in fact typical *Zea hirta* or hairy Mexican, a type of maize known only from the Mexican tableland.

The most pronounced evidence of hybridization was the presence of tuberculate hairs, which were found in all of the teosinte plants examined (Fig. 4); also the leaf sheaths were red. Neither of these characters had before been observed in pure teosinte. The segments of the rachis of the pistillate spikes were often pressed out of line; in some instances they were rather persistent and a few cases of paired seeds were observed, but after all no

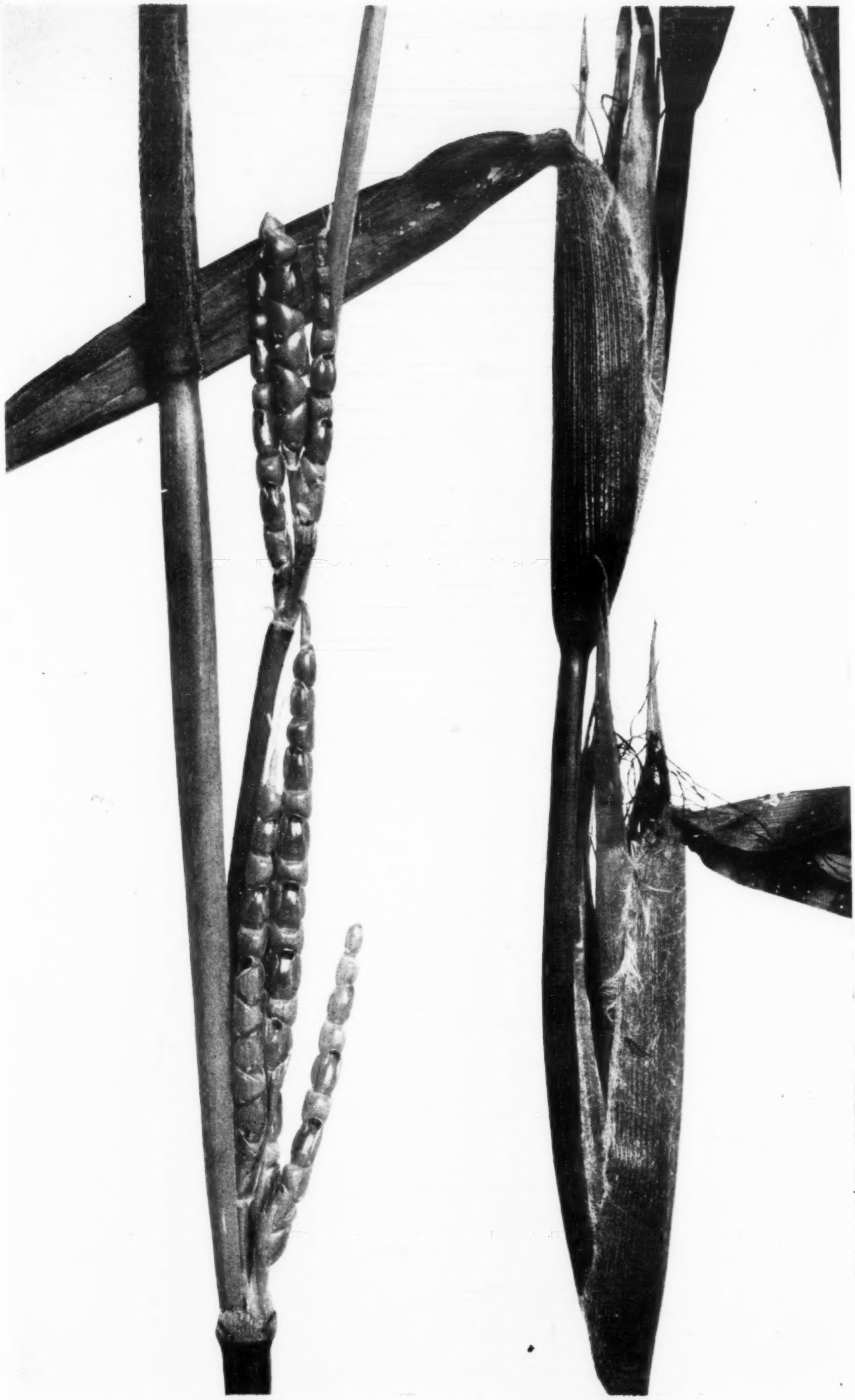
[2] Lopez Y, Parra, Rodrigo—El Teozinte, Mexico, 1908.

STAMINATE AND PISTILLATE INFLORESCENCES OF THE DURANGO TEOSINTE

The staminate inflorescence, shown above at the right, is not unlike a corn tassel, but there is little about the pistillate spike (left) to suggest an ear. Nevertheless, it is thought that the annual forms of teosinte (of which the Durango is one) may have originated as hybrids between the primitive, perennial teosinte and maize or Indian corn. (Fig. 1.)

TEOSINTE GROWING AS A WEED AT CHALCO, MEXICO

In certain parts of Mexico teosinte, a possible ancestor of Maize or Indian corn, grows as a weed in and about cultivated areas. The plants here shown are in a barley field near Mexico City. The ground was formerly a lake bed: it has been drained artificially in recent years. (Fig. 2.)



STALKS OF CHALCO TEOSINTE

The sheath has been removed from the specimen on the left, to expose the spikes. It may be seen that the lowest inflorescence is borne at the very base of the branch in the axil of the prophyllum. While this is a universal characteristic of teosinte, it is only in the region of Chalco that maize also produces an inflorescence in the axil of the prophyllum. (Fig. 3.)

plant was found with more than a suggestion of maize characters.

Both the maize and teosinte obviously were flowering at the same time and some explanation seems necessary as to why they do not completely intergrade. Since the evidence indicates a dilution of the teosinte rather than of the maize, the low stature of the teosinte may be a factor. Most of the tassels of the teosinte were borne at or below the level of the ears of maize.

The barley fields in which the teosinte was growing had been planted formerly to maize and it was apparent that the teosinte had volunteered. It was here that the most corn-like teosinte plants were found. No volunteer maize plants were found in the barley, indicating that the teosinte is much more tolerant of competition than maize. In fact, no maize plant could be expected to grow beyond the seedling stage in the presence of so much other vegetation.

Another factor in the failure of maize to volunteer may be the promptness with which it germinates. Maize seeds would, for the most part, germinate in the fall and be killed in the winter. On the other hand there is evidence that the seeds of teosinte require a period of rest before they will germinate. This might account also for the suppression of intermediates and maize-like teosinte plants, the seeds of which would be likely to germinate in the fall and not survive the winter.

The presence of tuberculate hairs and red sheaths in this teosinte is open to a number of interpretations:

(1) Most of the hybridization may be of ancient date and since intermediates would be preserved neither by nature nor man the two original types have been segregated except that characters of no survival value, such as tuberculate hairs and color of the sheath, have persisted in the teosinte; or

(2) The same causes which have favored the development of the color and hairs in the maize may have done the same for the teosinte; or

(3) If, as a result of the greater height of the maize plants, the crossing is teosinte female by maize male and not vice versa, hybridization may take place frequently; but since the hybrid seed would be borne on the teosinte plants it would not be harvested. The first generation hybrids, left to take care of themselves, might be so maize-like as not to survive in sufficient numbers to be observed.

Although teosinte was abundant in this particular locality, its distribution appears to be very restricted.

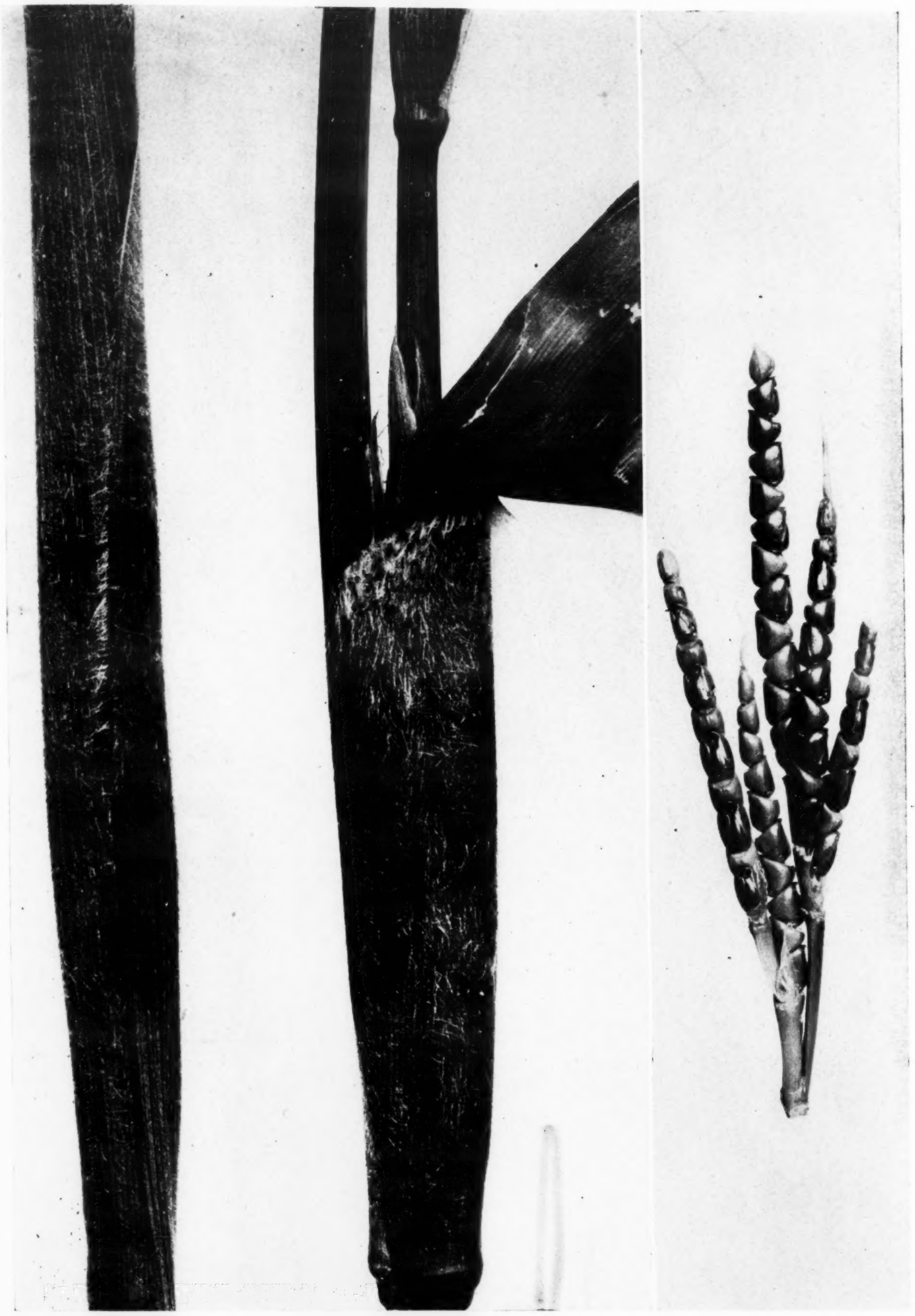
TRIPSACUM CONFUSED WITH TEOSINTE

Our experience at Coscomatepec, the next locality we visited, demonstrated that great caution must be exercised in accepting the localities that have been assigned as stations for teosinte. Dr. C. A. Purpus had reported teosinte as growing at Coscomatepec, a small town north of Cordova in the State of Vera Cruz, stating that it was there planted as a fodder plant and propagated by cuttings.[3] This novel method of propagation made this station of special interest.

There were persons in Coscomatepec who recognized the name teosinte and confirmed the statement that it was formerly grown as a forage. With the disturbances accompanying the revolution its growth was said to have been practically discontinued. A planting of this forage plant was eventually located in a walled-in garden in the town and proved to be a species of Tripsacum, probably *T. laxum*, a form common in Guatemala. In fact, the more generally recognized name for the plant at Coscomatepec is "*Zacate Guatemalteco*." According to the most accurate information we could obtain, Tripsacum was introduced originally into this region from Guatemala.

Thus it appears that the name teosinte is applied sometimes to Tripsacum. Before flowering, there is a superficial resemblance between Euch-

[3] Letter to D. G. Fairchild.



DOES WILD TEOSINTE SOMETIMES HYBRIDIZE WITH CULTIVATED MAIZE?

On the extreme left is a stalk of maize from Chalco, Mexico, and next to it one of annual teosinte from the same region. The covering of hairs on the leaf sheath of the latter is a new character in teosinte, and may have arisen through crossing with the hairy maize which is cultivated in this part of Mexico.

On the right is a well-developed pistillate inflorescence of Chalco teosinte. The triangular segments are not true seeds, but joints of the rachis in which seeds are embedded. (Fig. 4.)

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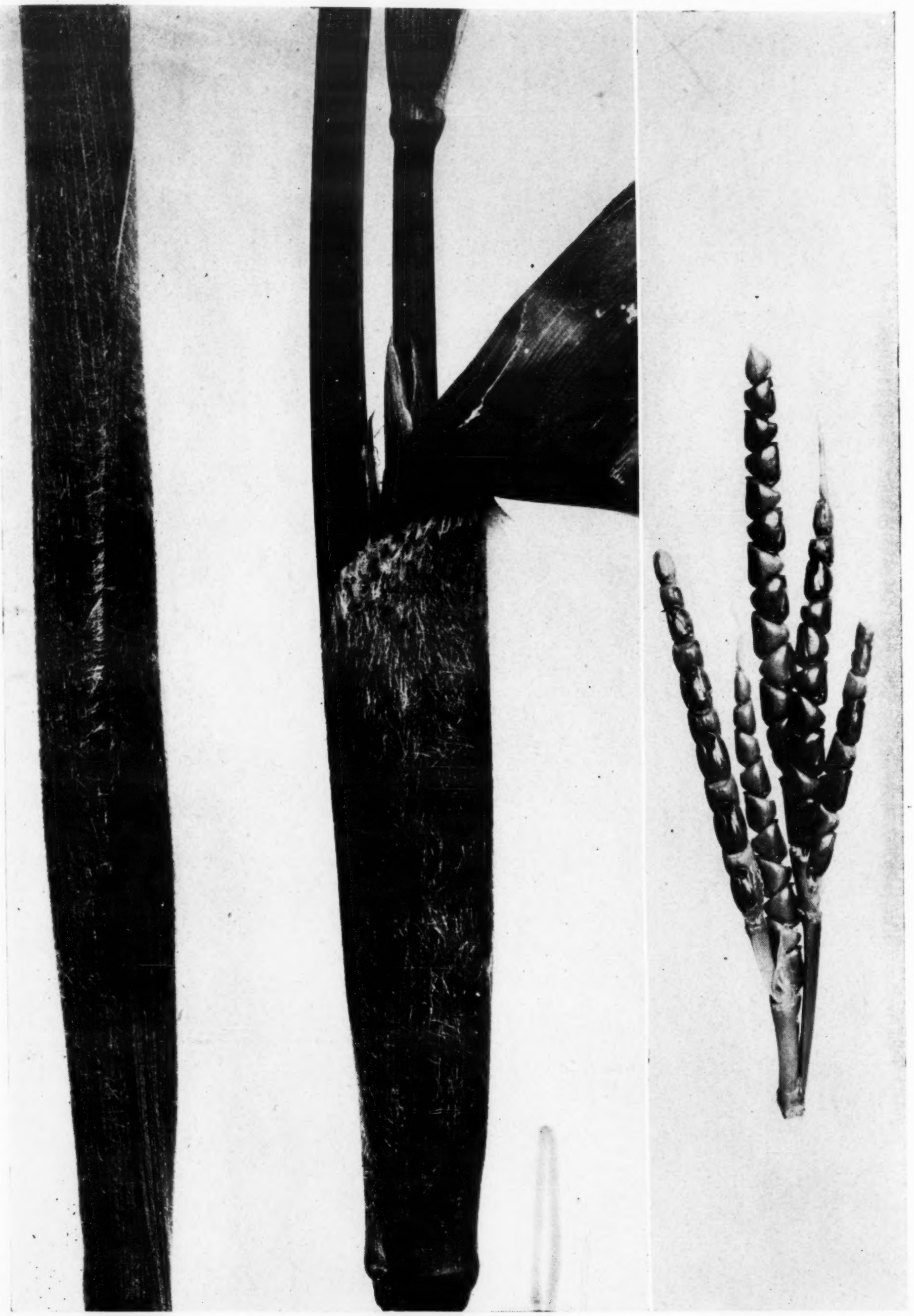

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PERENNIAL TEOSINTE, A POSSIBLE ANCESTOR OF MAIZE OR INDIAN CORN

It is believed that this type, which was found in the state of Jalisco, Mexico, is more primitive in character than annual teosinte, and that the latter may, in fact, have resulted from a cross between the perennial form and cultivated maize. (Fig. 5.)

laena and Tripsacum, but as soon as the inflorescences appear the two genera should not be confused by the most casual observer. We found later that the application of the name teosinte to Tripsacum was wide-spread in Mexico; for example, near the Ampara mines in the State of Jalisco there is a section of the country known by the name of "Los Teosintes." The natives say that the place is so called because of the abundance of teosinte growing in that locality. Here again the plant to which they refer proved to be Tripsacum, and no Euchlaena could be found in the region.

This confusion of common names makes it necessary to view with suspicion any localities assigned to teosinte that are not substantiated by herbarium specimens or adequate descriptions of the plant.

The fact that a broad-leaved Tripsacum is known as "*Zacate Guatemalteco*" and that it was introduced into at least one locality in Mexico from Guatemala makes it necessary to question the statement that Euchlaena is native in Guatemala.

PERENNIAL TEOSINTE

We next proceeded to Guadalajara to attempt the location of the perennial teosinte collection by Hitchcock in 1910. The locality given on the specimens in the National Herbarium, collected by Hitchcock, is "in prairie, along railroad, one mile south of the railway station of Zapotlan, Jalisco." We could locate no place in Jalisco named Zapotlan until an old map gave us the clue. Zapotlan had been changed to Cuidad Guzman. This city lies in a level valley surrounded by mountains on all sides except the south. The valley is perhaps twenty miles long by ten in width and is one large corn field divided by the railroad right of way and the narrow lanes that bound the fields allotted to the individual peons who grow the maize on shares. It seemed a most unpromising place to seek teosinte. The right of way where it had not been mowed recently was covered with a rank growth of sun-flowers, bidens, and other plants among which were a few grasses. Distances on the railroad were marked in kilometers and although there seemed little hope of finding teosinte in this tangled vegetation we began a very careful search after passing the first kilometer. At two and one-half kilometers, or almost exactly one mile, we found the plant we sought—a few small clumps in a part of the right of way that had been mowed recently.

That we were able to rediscover this plant at all is a striking demonstration of the importance of careful, systematic work and a tribute to Dr. Hitchcock's acumen as a collector and his painstaking accuracy in recording localities. We spent several days examining the country about Guzman, both in the mountains and in the valley, but were never able to find teosinte more than a short distance from the original station. Opposite the point where it was first found it spreads into the corn field as a weed, but is most abundant in one of the narrow paths leading through the field. An area one mile square would include all the plants we were able to find.

It should be noted that nowhere in Mexico did we find teosinte, either annual or perennial, as a wild plant in uncultivated areas. Its natural habitat seems to be flat, alluvial lands and since these are the very areas most desirable for agriculture, it is perhaps not to be expected that the plant would be found remote from cultivated regions.

Another important factor which tends to restrict teosinte cultivated areas is the promptness with which it is eradicated when the land is subject to grazing. Both teosinte and Tripsacum are sought eagerly by grazing animals with the result that teosinte is restricted to the cultivated areas that are protected artificially from domestic animals while Tripsacum is confined to steep, rocky slopes and deep ravines where it is out of the reach of grazing animals.

THE PRIMITIVE FORM OF TEOSINTE

In this illustration are shown, natural size, a leaf, staminate inflorescence, and pistillate spikes of perennial teosinte from the state of Jalisco, Mexico. A comparison of these spikes with those of the annual forms shown in Figs. 1 and 4, brings out the fact that the segments of the latter are definitely triangular, while those of the perennial type have the lateral apex of the triangle somewhat flattened, as in Florida teosinte. (Fig. 6.)

SPIKES OF PERENNIAL TEOSINTE CONTAMINATED WITH MAIZE

Here are shown, natural size, pistillate spikes of the perennial form of teosinte from the state of Jalisco, Mexico, which have been contaminated by maize or Indian corn. A sure indication of maize ancestry is the crowding of the segments, and the consequent forcing of the joints into a zigzag position. (Fig. 7.)

The development of rhizomes was a constant feature in all the teosinte at Ciudad Guzman. (Fig. 5.) The plant is undoubtedly perennial and distinct from all the forms of teosinte previously known.

Further explorations are needed, especially in Guatemala, before deciding whether the Durango and Florida forms should be placed in separate species, but the perennial form is undoubtedly a new species.

In the form of the seed the perennial teosinte more nearly resembles Florida teosinte than that found at Durango or Chalco. (Fig. 6).

One plant was found with double female alicoles, a persistant rachis, and seeds protruding slightly beyond the glumes, a combination of characters not uncommon in the second generation of maize-teosinte hybrids. (Fig. 7.) The discovery of this plant showing maize characters makes it seem certain that this new teosinte will cross with maize and produce fertile hybrids. Although teosinte was growing among the maize plants and the two species had flowered simultaneously, this single plant was the only evidence of hybridization that could be found.

By reason of its perennial nature, this new species of Euchlaena is less maize-like than the annual forms of teosinte and at once suggests that the latter may have arisen through the hybridization of a perennial teosinte with maize. The evidence for this view is altogether too meager to more than raise the question, but it should be recalled that in the only instance that teosinte was found in a region where the maize possesses distinctive characters, these same characters were found in the teosinte.

Fortunately it should be possible to give a definite answer to this question in two or three years. If forms closely resembling the annual types of teosinte can be developed from hybrids between perennial teosinte and maize, there would seem little reason to doubt that wild types of annual teosinte have arisen in this manner. On the other hand, if the annual character cannot be separated from the other teosinte characters the theory must be abandoned.

CONCLUSIONS

Teosinte was found growing wild in three distinct localities: annual forms in Durango and the State of Mexico, and a perennial form in Jalisco.

Although occasionally cut for fodder, teosinte was nowhere found to be cultivated. On the other hand, it was not found as a wild plant outside of cultivated areas.

The natural habitat of all forms appears to be level, alluvial lands, not subject to extreme drought. The grazing of animals restricts it to protected areas.

None of the forms of teosinte are common or widely distributed. In the regions where they occur, they attract little attention and then only as a weed in maize fields.

Although teosinte and maize were growing in close proximity, there is little evidence of natural hybridization.

The name teosinte is frequently applied to species of Tripsacum—a fact that has led to much confusion regarding the natural distribution of teosinte.

There is a perennial form of teosinte that differs from all previously known types which are annual by the production of rhizomes.

In its seed characters the perennial form of teosinte resembles the cultivated teosinte of Florida more closely than it resembles the annual varieties of Mexico.

If all the forms of teosinte are descended from a single stock, it seems reasonable to believe that of the known forms the perennial species most closely approximates this common ancestor.

Since the annual forms of teosinte occupy a position between perennial teosinte and maize and since at least one form of annual teosinte is distinguished from the others by characters which it shares with the maize of the region in which it grows, it is suggested that the annual types of teosinte may have originated from hybrids between perennial teosinte and maize.

THE CELL MECHANISM

A Review of Sharp's Cytology

THE present condition of cytology as one of the most actively developing biological sciences is indicated by the appearance in little more than a year of three new text-books on the subject, two from England and the American one which is the subject of this review.[1] The source of this increasing interest in morphological cytology evidently lies in its inter-relations with genetics and with cell physiology.

Professor Sharp's book is well planned and modern in its view-point. It gives an adequate historical background and extensive bibliographies; each of the general subjects treated is followed by a bibliography which should render available a complete list of titles to anyone who followed up those given. It is efficiently indexed, all generic names in the index are followed by some word showing the general systematic position of the organism. This is a feature which will be found very convenient. The book is well balanced; some 214 pages deal with such subjects as "Protoplasm," "Metaplasm," "Polarity," "Plastids and Chondriosomes," etc.; 86 pages are devoted to the chromosomes; and the last 104 pages to the theories and laws of heredity and the relation of the latter to the chromosomal mechanism.

A number of the text-figures are diagrams which show the behavior of the chromosomes with the greatest simplicity. Indeed, to the reviewer, certain diagrams like those on pages 228 and 229 where, for the sake of clearness, the second maturation division is not represented, seem to have gone too far in this direction. Other diagrams are excellent, e. g., the two on page 341 which give the parallelism between the distribution of an allelomorphic pair of Mendelian characters and of a homologous pair of chromosomes.

For the majority of the readers of this Journal, the parts dealing with the chromosomes and heredity are the ones of most interest and, so far as the principles involved are concerned, they are presented in such a way that it would seem that a person with no technical training in either cytology or genetics could read the book and grasp them. However, the real usefulness of the book depends on its value as a cytology text and a close inspection from this standpoint leaves one disappointed in several respects. A first edition of a book of such wide scope almost inevitably contains some errors. This one presents a rather large number, and it seems necessary to consider these at some length because this work comes nearer to meeting a definite need for a text-book of cytology than any other available.

The chief difficulties will be considered under three headings with brief examples.

1. A lack of clearness and precision of expression. Usually an experienced cytologist could arrive at the meaning, but a thoughtful beginning student will meet considerable difficulty with a sentence such as this, pp. 351, "If—the mutation is such as to result in a recessive character, this character does not manifest itself until it meets a similarly mutated gene in the homozygous individual." In this brief sentence, there is evidently confusion as to character and gene, while the meaning of the latter part of the sentence can only be surmised. Perhaps one of the ideas is that when two gametes each bearing similar genes for some character meet they give rise to an individual homozygous for that character.

[1] Introduction to Cytology, by Lester W. Sharp, Ph.D. pp. 452 with 152 text-figures. New York, McGraw-Hill Book Co. 1921.

A somewhat different type of lack of precision is shown in numerous instances and may be illustrated by this sentence from p. 344, "The 12 pairs of chromosomes in man may in the same way form several million such combinations." Some 18 pages further on, one learns that there is considerable disagreement as to the number of chromosomes in man. This lack of care in making unqualified statements is one of the most disconcerting features of the book.

2. Lack of Accuracy: On page 362, Fig. 141 we find certain figures copied from Wieman marked as follows:—"A, primary spermatocyte, negro; B, same, white." The first is a growth period nucleus, the second a first spermatocyte metaphase, consequently the very striking difference in their appearance can scarcely be attributed to the fact that one is from a negro and the other from a "white." In Wieman's plates, they are correctly designated.

Another example which the reviewer hesitates to mention is in regard to the recognition of the sex chromosome; credit is rightly given to Henking (1891) for the discovery that a body which he thought to be a nucleolus or "chromatin body" was distributed to ½ of the spermatozoa; then follows this statement (p. 358), "It was subsequently shown by Paulmier (1899), Montgomery (1901), and de Sinety (1901) that this body is not a nucleolus but an extra or accessory chromosome," and finally, "It was at once suggested by McClung (1902), that the accessory chromosome in some way determines sex." As a matter of fact, the term accessory chromosome was introduced by McClung in 1899 and the suggestion as to the probable function of the chromosome was made by the same author in 1901.

Inaccurracies of the kinds referred to so far will doubtless be largely removed from later editions. A more serious feature remains to be considered.

3. The interpretation of chromosomal behavior at critical stages. On lines of work in which the author has not engaged the presentation of the facts and the arguments pro and con are usually well given, while conclusions based on his own observations are certainly not applicable to a great deal of material which might be used in a cytological course. To be specific, his description of the longitudinal splitting of the chromosomes by the formation of a series of vacuoles in the prophase, while coinciding with a great deal of botanical literature on the subject, is in conflict with what clearly takes place in many animals where each chromomere divides. Sharp (p. 155) discredits the existence of chromomeres on the basis of his own work and considers the chromatic thread as homogeneous. The generally accepted view on this subject may perhaps best be indicated by a quotation from Agar's recent cytology. He says in regard to chromomeres (p. 134), "This condition, which forms one of the most characteristic sights met with by the cytologist, can be illustrated by reference to almost any work dealing with mitosis, whether in the soma, germ track of during meiosis. . . . It is equally characteristic of animals and plants." Since genetical evidence leads us to expect just such a linearly arranged series of units as the chromomeres in fact furnish, they are of considerable importance both from the standpoint of heredity and cytology.

Another position taken by Sharp which is not satisfactory to one familiar with animal cytology is in regard to the maturation phenomena—again a stage of prime importance from the standpoint of heredity. In common with the majority of botanists, Sharp describes the chromosomes of the first maturation division as bivalent in structure. The outstanding characteristic of the prophase of the first maturation division is the tetrad or chromosome composed of four equal parts due to the longitudinal splitting of the synapsed homologues. Sharp states (p. 234), "The diakinesis stage is terminated by the dissolution of the nuclear membrane and the formation of the spindle, upon which the bivalent chromosomes,

whether secondarily split or not, now become arranged. Because of the peculiar form and consistency of the heterotype chromosomes the mitotic figure presents a striking contrast in appearance to the ordinary figure of somatic cells." This "striking contrast," however, depends wholly upon the fact that the chromosomes are "secondarily split," that is, that they are tetrads and not dyads. The writer has had enough contact with botanical material to be confident that this statement is true for plants as well as animals. A number of the more recent plant cytologists have recognized the tetrad nature of the chromosomes of the first maturation division.

The manner in which the chromosomes split, the existence of chromomeres, and the structure of the first maturation chromosomes are all matters of prime importance in cytology and genetics and since this is a book which, on account of its many excellent qualities, is sure to be largely used as a text-book, it becomes a clear duty to indicate these weaknesses. However, a capable instructor with suitable material for demonstration may easily show the real conditions and thus turn these points to advantage in teaching students independence of observation.

In conclusion: this book seems adapted to meet the needs of several classes of people, among them the general reader seeking to enlarge his field of knowledge and the practical breeder who wishes better to comprehend the physical mechanism through which he obtains his results. The beginning student of cytology should find it interesting because of the emphasis which is placed on the problems which are now attracting most attention. The instructor who wishes a text-book will find the subject presented in a well-rounded manner. While to the zoological cytologist, the book will be especially useful since it stresses the views of the botanists and makes their results more readily accessible.—*E. Eleanor Carothers.*

The Improvement of Citrus Fruits

That the study of bud variation in plants, frequently thought of as the harmless amusement of amateur horticulturists, has led to an increased production of citrus fruits valued at more than a million dollars annually, is a fact that should be of more than passing interest to the members of the Genetic Association.

In a recent paper,[1] Mr. A. D. Shamel calls attention to the importance of this method of improving our agricultural plants and shows that a surprising number of the leading varieties of most of our perennials have originated as bud sports or mutations. That Mr. Shamel himself has taken a leading part in this work and that it is chiefly through his efforts that the value and importance of bud selection now is being appreciated, is modestly concealed. The paper gives a brief but explicit description of the methods that have been followed in the bud selection work with citrus fruits.

Mr. Shamel also announces that preliminary work with sugar cane in Hawaii gives definite indication that a corresponding improvement in that crop also may be brought about by applying similar methods. The results of bud selection in a great variety of plants are brought out in a vivid and striking way by the 41 beautiful full-page illustrations.—G. N. C.

[1] "The Improvement of Plants Through Bud Selection," A. D. Shamel, Experiment Station of the Hawaiian Sugar Planters' Asso., March, 1921.

THREE NEW MUTATIONS IN OENOTHERA LAMARCKIANA

Interesting plant forms found in a strain of evening primrose obtained from Professor De Vries. These mutants, showing new variations in leaf structure, pigmentation of stalk and buds, and color of flowers afford further material for analysis of this important group.

GEORGE H. SHULL
Princeton University, Princeton, New Jersey

ANY one engaged extensively in breeding Oenotheras discovers many new as well as old mutant types. The less striking of these are identified with difficulty and it does not seem desirable to encumber the literature with distinctive names for them. Now and again, however, a form appears which has such definiteness that it may be profitably used in breeding experiments, and references to these are facilitated by assigning to them names in harmony with the names already published for the other mutant types.

Among the mutations which have appeared in my cultures there are several which have exceptional interest and these are being used in numerous breeding experiments. Since they are destined to enter to a greater or less extent into the future literature of the group and since they have a certain amount of interest in themselves, quite independently of the experiments in which they are being employed, it seems desirable to give them a publicity which will serve to validate the names which are being used in the notes on their genetical behavior.

Since 1905 I have been keeping, in addition to many other Oenothera cultures, a strain of cross-bred *Oenothera Lamarckiana* which originated from nine original rosettes collected for me by Professor de Vries in the same field at Hilversum, Holland, from which he had secured the material for the initiation of his own Oenothera cultures about twenty years before. These cultures have been maintained, year after year, by crossings so arranged that every progeny in the strain has had four distinct grandparents. The three mutations here described have all arisen in this cross-bred strain.

Oenothera Lamarckiana mut. *funifolia* mut. nov.

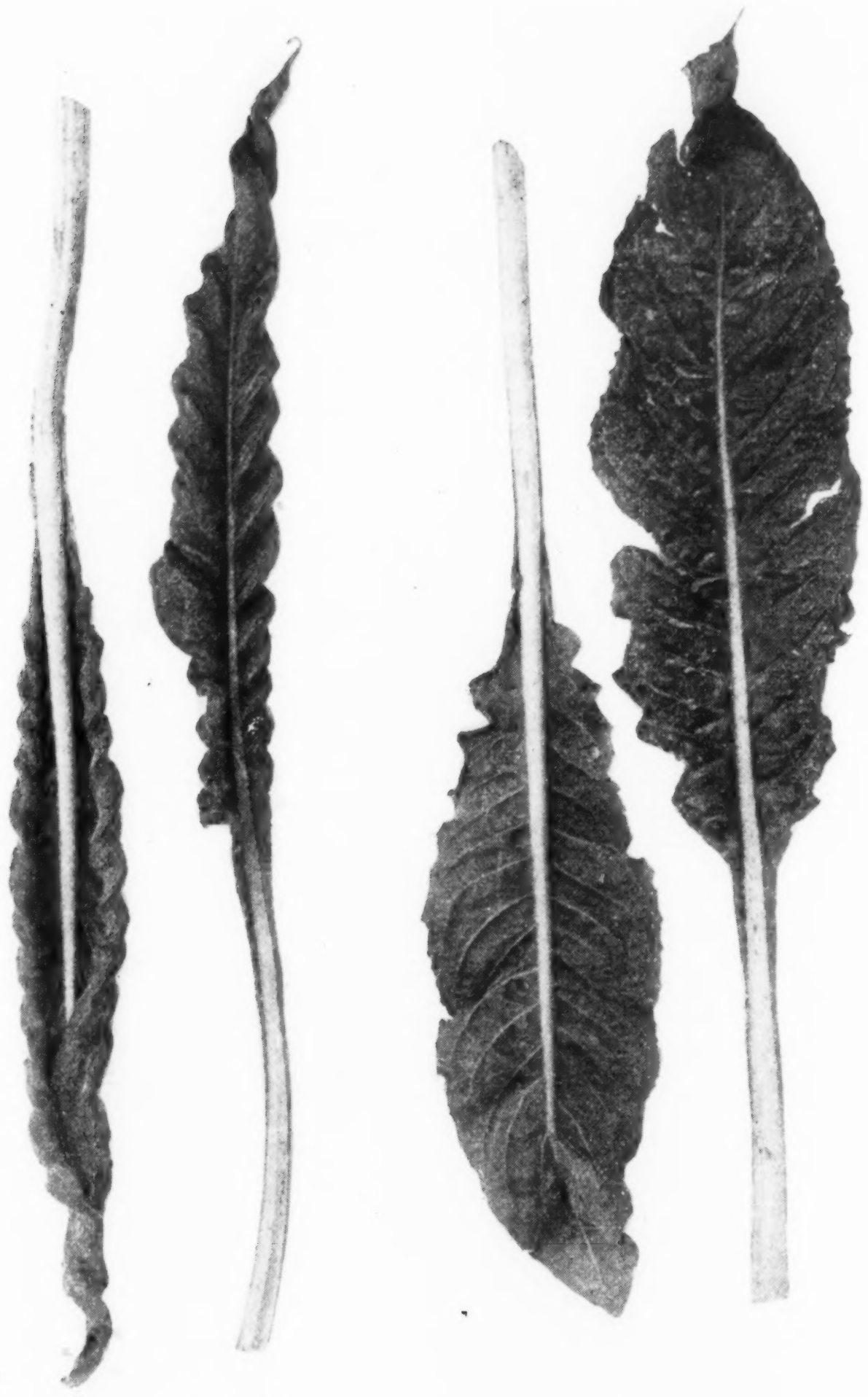
DESCRIPTION OF STRUCTURE AND ORIGIN OF NEW VARIATION WITH NOTES ON ITS SIGNIFICANCE

The most characteristic feature of the new mutation which I am calling *Oe. Lamarckiana* mut. *funifolia*, is the strong revoluteness or downward curl of the leaf margins, which in the best developed examples causes the leaf to have almost a cylindrical form. The leaf tissue between the lateral veins becomes more strongly contracted than the veins thus giving the leaves an appearance superficially resembling that of a braided rope, as shown in Figs. 8 and 9. Cross-sections of the leaves of *Oe. Lamarckiana* and of *Oe. Lamarckiana* mut. *funifolia* are shown in Fig. 10. Associated with this revoluteness of the leaf margins is an irregular fine rugosity of the ventral (convex) surface of the leaves which gives the plants a markedly grayish aspect (Fig. 11). In most strongly revolute specimens numerous small protuberances often occur on the ventral surface of the leaves, on either side of the midrib (Fig. 12). A section of one of these protuberances is shown in Fig. 13, where it is seen to differ in structure in no essential way from the body of the leaf from which it arises. There is also some modification of leaf outline, the leaves being usually rela-

THE FUNIFOLIA MUTANT OF OENOTHERA LAMARCKIANA

The most striking characteristic of this mutation is the curled leaf margin, which gives the appearance of braided rope, whence the name *funifolia*. It differs also from its parent, *Oe. Lamarckiana*, in having no basal branches. This is one of three new mutants which are likely to be of much use in breeding experiments, and which are described at length in the text. Photograph by James P. Kelly. (Fig. 8.)

tively narrower and, particularly in the stem-leaves, usually narrowing rather abruptly to short-acuminate apexes which are sometimes almost spinescent. Occasionally the midribs of some of the stem-leaves end in a short sub-apical spine-like spur on the under (dorsal) side of the leaf, a characteristic which is much more strikingly and consistently associated with revolute leaves in *Oenothera pratincola* mut. *formosa* Bartlett. When typically developed the *funifolia* plants can be detected readily in very early rosette stages (Fig. 14 left) but in less fully developed plants of this type the revolute character does not appear conspicuously in the earlier leaves of the rosette, and the revolute



FUNIFOLIA COMPARED WITH ITS PARENT

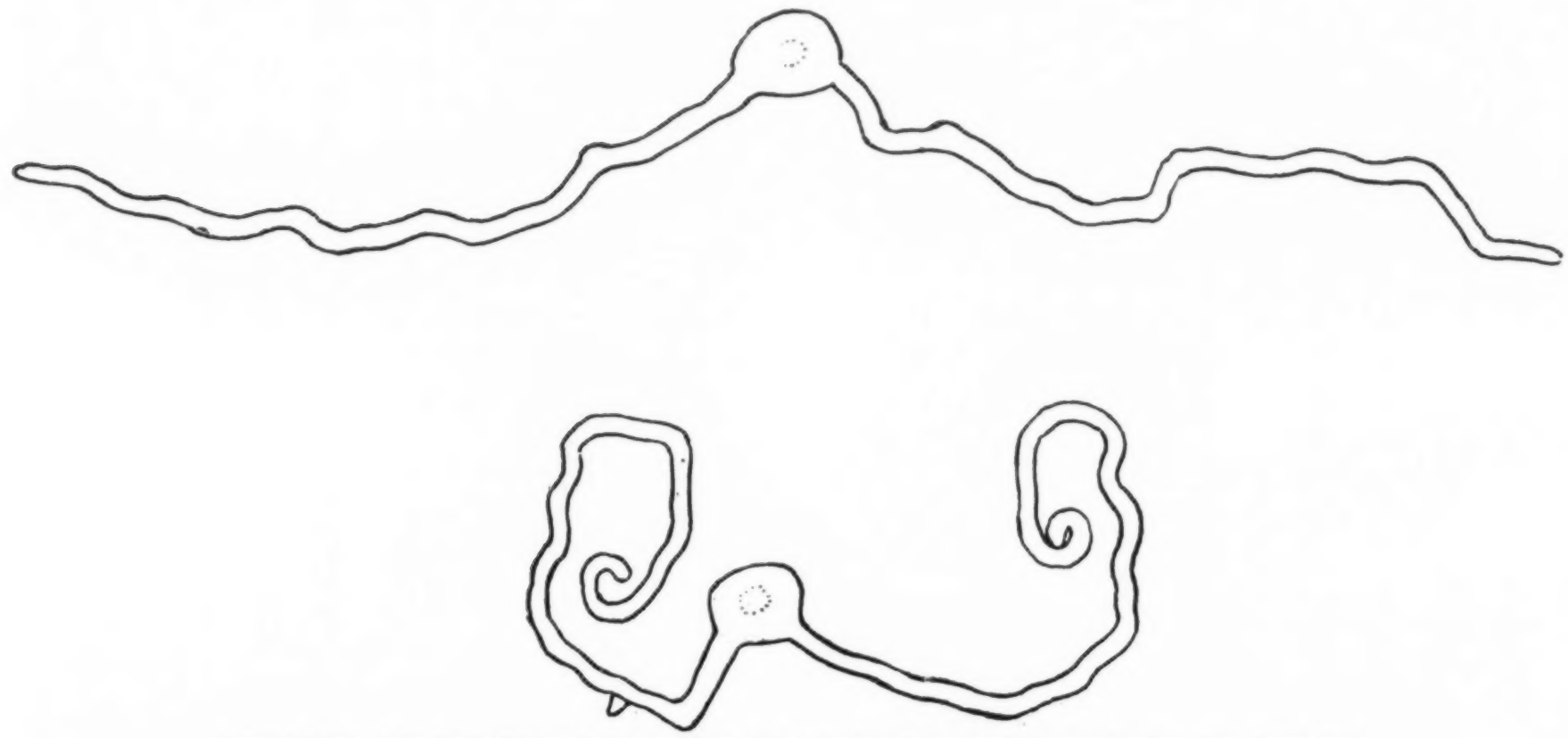
On the left are two leaves (one showing the ventral surface, the other showing the dorsal) of the *funifolia* mutant; on the right are two of the parent, *Oe. Lamarckiana*, arranged in the same manner. Here is brought out in striking manner the difference in leaf-form which has entitled the mutant to the name *funifolia*. In addition to their narrower shape, the leaves of *funifolia* are grayish on the ventral surface, a characteristic which is not found in the parent. Photograph by James P. Kelly. (Fig. 9.)

margins are limited to the basal portion of the leaf-blade. This under-development of the *funifolia* characters has been particularly noticeable in the case of *funifolia* segregates from crosses with *Oe. franciscana*. This result in the case of the *franciscana* cross is doubtless related to the fact that the latter species has thicker, stiffer leaves than *Oe. Lamarckiana*, and that the stiffness of the leaves is to a certain degree antagonistic to the revoluteness produced by the *funifolia* factor. In all cases, however, the *funifolia* character has been sufficiently well developed, that an error of classification has occurred only in one or two cases.

In the adult stage the chief difference between mut. *funifolia* and its parent, *Oe. Lamarckiana*, aside from the revolute leaves of the former, consists in the lack of basal branches in *funifolia*, such as are invariably present in *Lamarckiana*. The characteristic habits of these two forms are well shown in Figures 14 (right) and 15.

SUDDEN APPEARANCE OF SEVERAL MUTANTS OR "MASS MUTATION"

The first *funifolia* plants appeared in 1918 in pedigree family number 1720, the offspring of a self-fertilized *Lamarckiana* of the cross-bred strain mentioned above. There were five individuals of the *funifolia* type in a family consisting of 100 individuals, 90 of which were typical *Oe. Lamarckiana*. When these five plants were first observed in pot culture in the greenhouse they had the appearance shown in



LEAVES OF FUNIFOLIA AND ITS PARENT, IN CROSS SECTION

The lower diagram represents a leaf of the *funifolia* in cross section, the upper one, a leaf of *Oe. Lamarckiana*. (Fig. 10.)

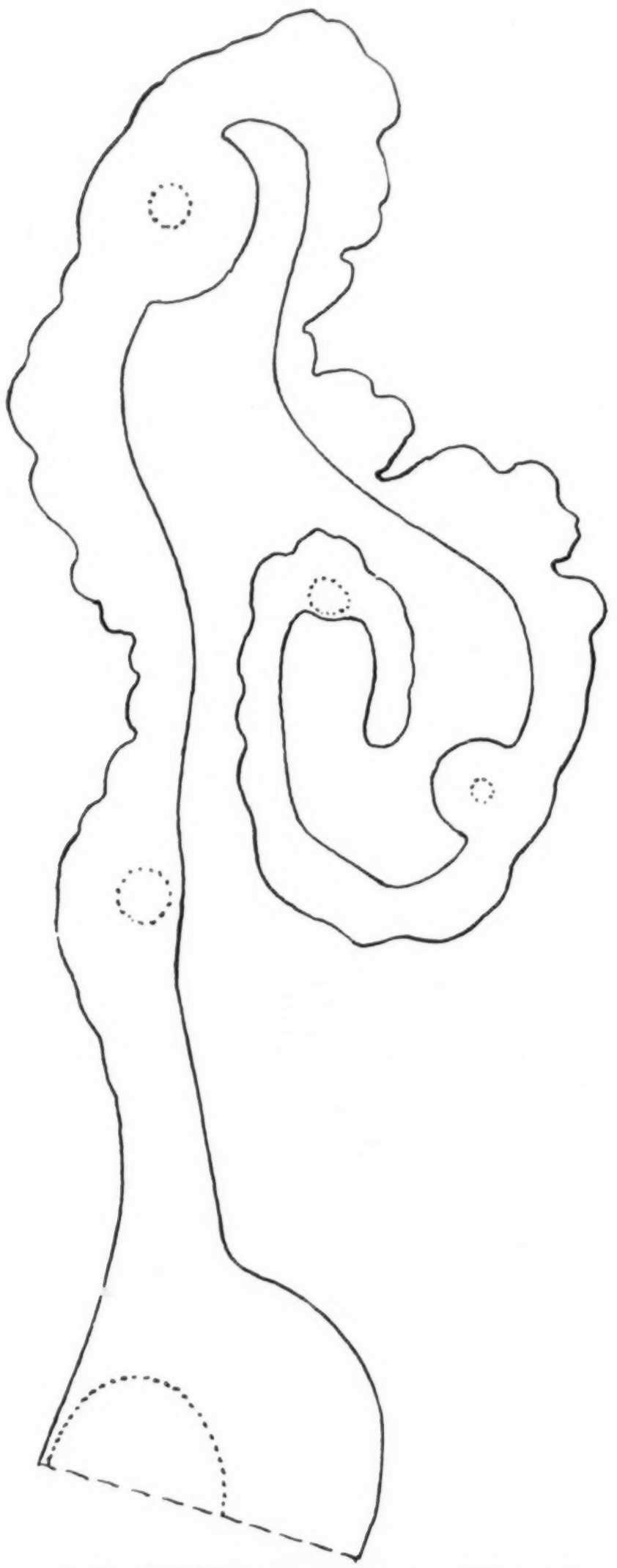
Fig. 16. At this stage the characteristic constrictions between the lateral veins are not present. The revolute leaves and grayish aspect suggested at first that these five plants were diseased, but it was demonstrated later that they were permanent normal hereditary characteristics.

This sudden quintuple appearance of a striking new type which had never before appeared in the extensive cultures of *Oe. Lamarckiana*, illustrates the phenomenon which Bartlett has called "mass-mutation," and the breeding tests which have indicated the method of origin of *funifolia*, may be used as a basis of interpretation of other cases of so-called "mass-mutation." The crosses of these five *funifolia* plants with their *Lamarckiana* sibs, and with *Lamarckiana* plants in other families, showed that the parent of family 1720 had been heterozygous for *funifolia*, but that the *funifolia* factor did not occur in any of my other *Lamarckiana* families, either in the independent strains or in the families most closely related genetically to family No. 1720. The conclusion seems justified therefore that the *funifolia* factor arose as a gene-mutation in 1916 in the production of the egg or the sperm whose mating resulted in the parent of family No. 1720.

Since *Oenothera Lamarckiana* is maintained in a heterozygous state by the presence of the two lethals, l_1 and l_2, in chromosome I, *funifolia* could become visible only through the process of crossing over. The relatively frequent crossing over of the *funifolia* factor from chromosome I*a* into chromosome I*b* or *vice versa* shows that there is an appreciable distance (possibly about 20 units) between the locus of the *funifolia* factor and the loci of the characteristic *Lamarckiana* lethals, l_1 and l_2. The only difference between "mass-mutations" and single (crossover) mutations is attributable to the fact that the loci of the former are relatively distant from the limiting lethals while the loci of the latter are very near to the lethals.

OTHER PARALLEL MUTATIONS

Perhaps the most interesting fact regarding mut. *funifolia*, is its status as a probable parallel mutation, since its characteristics are in essential agreement with those of Bartlett's *Oe. pratincola* mut. *formosa*. *Oenothera pratincola* and *Oe. Lamarckiana* are so unlike in every way that one can not logically assume a common ancestor except in a relatively remote past. If it should turn out, as I anticipate, that the *funifolia* factor in *Lamarckiana*



ENLARGED SECTIONAL VIEW OF FUNIFOLIA LEAF

One of the characteristic features of the *funifolia* mutant is the rugosity of the ventral (convex) surface. This is clearly brought out in the above drawing, which was made by J. Marion Shull from a mounted specimen. (Fig. 11.)

and the *formosa* factor in *pratincola* occupy identical loci, it will lend the strongest possible support to the view to which I have been led by other considerations, that there is a widespread homology of genotypic constitution in the Oenotheras. The necessary crosses have been made to test this question.

Oenothera Lamarckiana **mut.** *pervirens* **mut. nov.**

AN ALL-GREEN, RECESSIVE MUTANT FACILITATING ANALYSIS OF PIGMENTATION FACTORS

Oenothera Lamarckiana, as is well known, is characterised by pink-coned buds and greenish stems bearing numerous papillate hairs, of which the papillae are strongly reddened with anthocyanin pigment. There are, in addition, numerous characteristic details of form and size of all its parts. Breeding experiments have shown that *Oe. Lamarckiana* is a permanent heterozygote in regard to certain factors carried in one of its chromosome pairs (chromosome I), and that in one member of this pair (I*a* or "velans[1]") there is a factor for red bud-cones which is only partially dominant to the recessive factor for green or greenish bud-cones which occupies the corresponding locus in the other member, I*b* ("gaudens"[1]). It is probably the lack of complete dominance of the red-cone factor R^c, which gives *Oe. Lamarckiana* its characteristic pink cones. The presence of the recessive green-cone factor r^c is easily demonstrated by crosses between *Oe. Lamarckiana* and species characterized by green bud-cones, as this represents the back-cross of a heterozygote to the corresponding recessive and results in a 1 : 1 ratio, except as the ratio may be modified by linkage with lethal factors or by selective elimination. The presence of this receisves green-cone factor (r^c) is also evidenced by the frequency with which mutant derivatives of *Lamarckiana* have green or greenish buds. In most cases these green-budded mutants differ from *Lamarcki-*

[1] Names by which O. Renner has distinguished the two hereditary constitutions possessed by different germ-cells in *Oe. Lamarckiana*. They may be retained as names of the two members of chromosome pair No. I in this species.

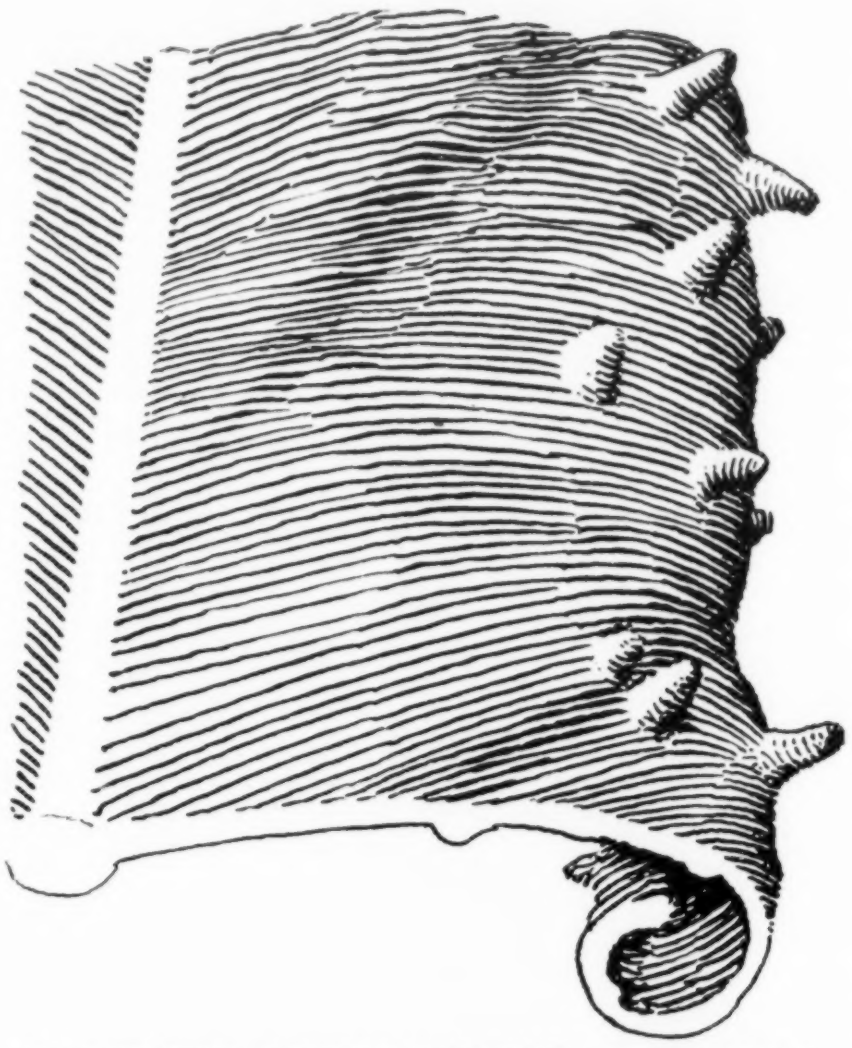
ana in many details of form, but in 1920 in family No. 193 there occurred among 78 typical *Lamarckiana* plants and 1 *bipartita*, one plant which was indistinguishable from *Lamarckiana* in nearly all details of form and size, but which had the buds entirely free from any trace of red pigment. The color of the papillae on the stems was not observed, but as all of the offspring of this plant by self-fertilization, have been wholly free from red papillae it may be assumed with assurance that this original specimen of mut. *pervirens* was characterized not only by wholly green buds, but also by wholly green stems.

SIMILARITY TO LAMARCKIANA SHOWN BY PARALLEL MUTATIONS

That mut. *pervirens* has essentially the same genotypic constitution as *Lamarckiana*, except in this complete loss of red pigmentation, is indicated by the composition of its progeny (No. 2046) for not only were there 140 *pervirens*, practically indistinguishable in form and habit from *Lamarckiana*, but there were in addition to these, two mut. *lata*, one mut. *oblonga* and one mut. *bipartita*, which differed from the parallel forms found in *Oe. Lamarckiana* only in being wholly free from red-pigmentation on buds and stems. There were also five unidentified mutants, one of which closely resembled *scintillans*, another *nanella* and a third *bipartita*.

ABSENCE OF PIGMENT AN AID TO GENETIC ANALYSIS

Since 1913 I have been tracing the genetical behavior of a factor R^s for intense reddening of the stems, but have had difficulty in many combinations because forms which do not possess this factor frequently show considerable reddening of the stems. In these the redness of the stems advances with advancing age, and is especially intensified with the onset of autumn coloration, so that classification into red-stemmed and green-stemmed series has become increasingly difficult in some crosses,with



WARTLIKE OUTGROWTHS, A CHARACTERISTIC OF THE FUNIFOLIA MUTANT

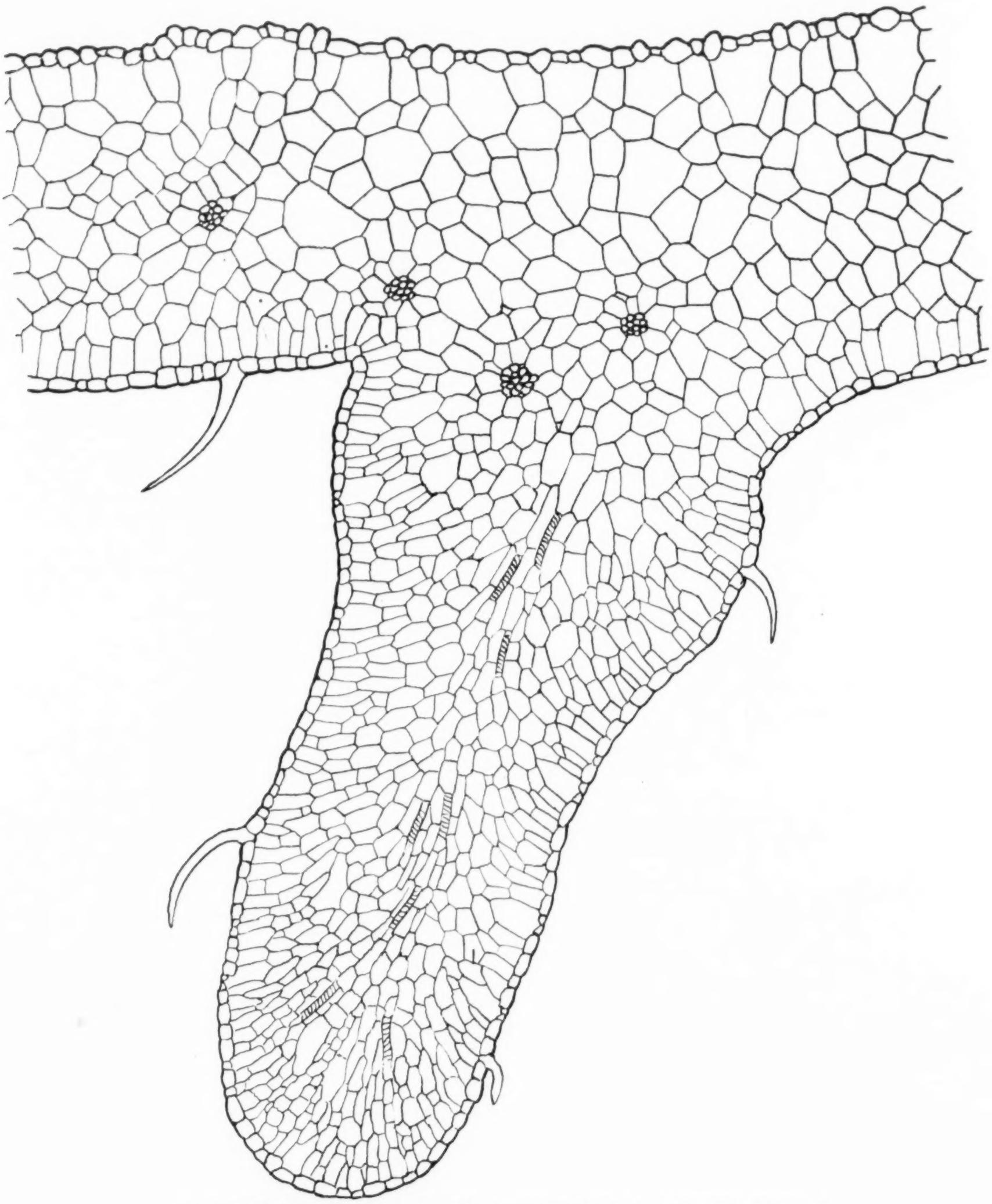
The above sketch, drawn by J. Marion Shull, shows a portion of a leaf of the funifolia mutant bearing the peculiar wartlike outgrowths which frequently occur on highly developed specimens of this type. (Fig. 12.)

the advance of the season. The great advantage to be derived from the discovery of a form wholly free from red pigmentation, and having at the same time the splendid qualities of vegetative vigor and fecundity which have made *Oenothera Lamarckiana* such a satisfactory subject for genetical studies, will be sufficiently obvious, and it may be confidently expected that with the aid of a recessive type which is free from red coloration on both buds and stems, and whose stems show no trace of autumn reddening the pigmentation factors will be capable of a much sharper analysis than has been possible heretofore.

Oenothera Lamarckiana mut. *vetaurea* mut. nov.

THE FIRST BREAK IN FLOWER COLOR IN VARIANTS OF LAMARCKIANA

Few characters are more constant throughout a large genus than is the yellow flower color of the Oenotheras.



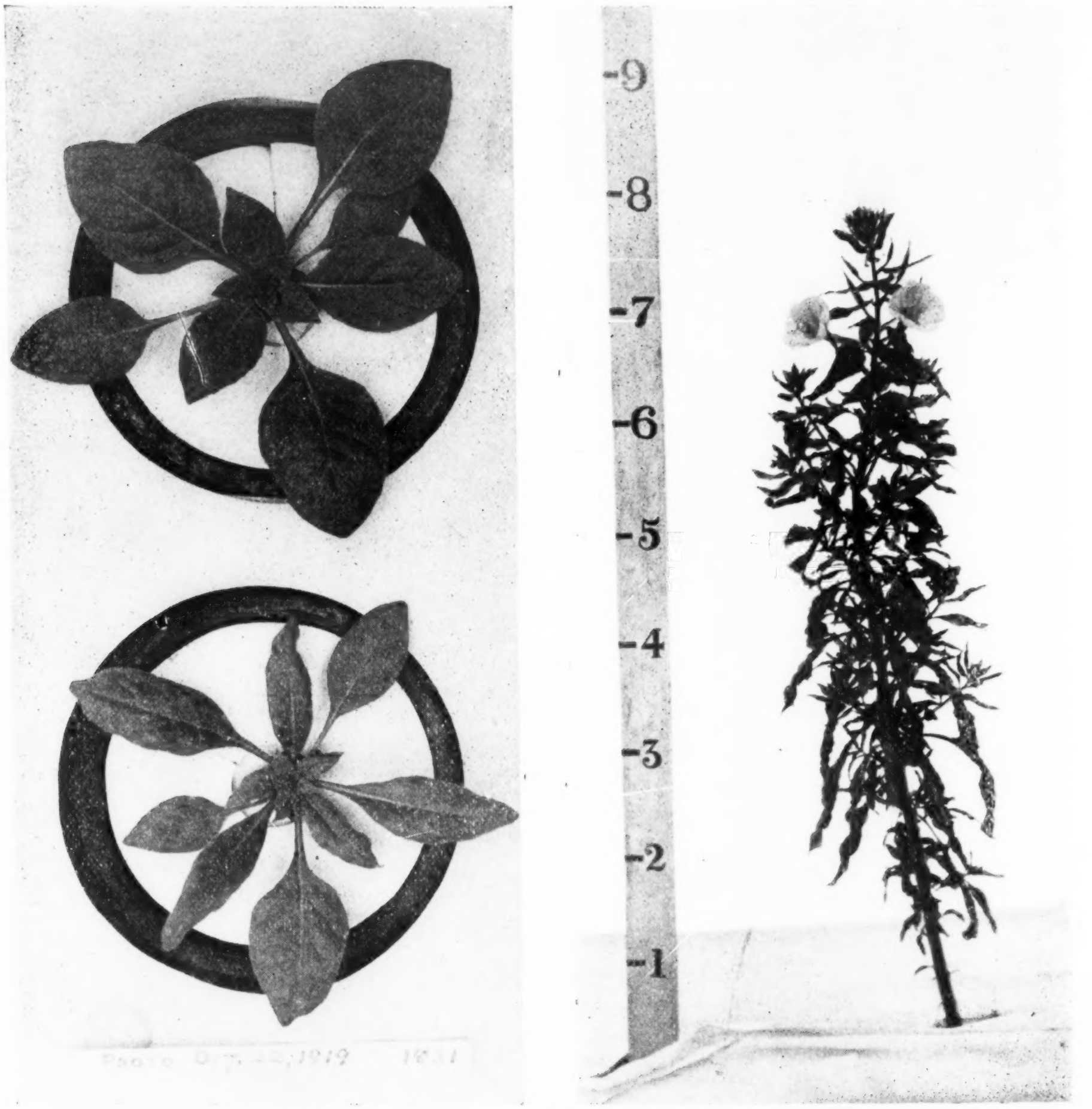
ENLARGED SECTION ON A FUNIFOLIA OUTGROWTH

In this drawing, made by J. Marion Shull, is shown in detail the structure of one of the peculiar outgrowths which characterize the *funifolia* mutant. (Fig. 13.)

For hundreds of years, however, a *sulfurea* or pale yellowish-white form of *Oe. biennis* L. has been known, widely distributed in Europe, and more recently the same variation has been observed in *Oe. suaveolens*, also, in nature. *Sulfurea*-flowered mutants have also arisen in experimental cultures of Stomps[2] and de Vries,[3] and the *sulfurea* factor has also been introduced into other species by means of hybridization, and has yielded

[2] Stomps, Theo. J. Parallele Mutationen bei *Oenothera biennis* L. Ber. Deutsch. Bot. Gesell. **32**: 179-188. 1914.

[3] de Vries, Hugo. Mutations of *Oenothera suaveolens* Desf. Genetics **3**: 1-26. 4 fig. Jan., 1918.



CHARACTERISTICS OF THE FUNIFOLIA MUTANT

The illustration on the left shows (above) a young rosette of *Oe. Lamarckiana*, and (below) one of the *funifolia* mutant. When typically developed, the mutant can be detected even in very early rosette stages.

On the right is shown an adult plant of the *funifolia* mutant. By comparison with Fig. 15, it will be seen that the mutant is distinguished from its parent by the complete lack of basal branches. (Fig. 14.)

genetic results of the utmost value in working out the genotypic constitution of the Oenotheras. So far as I know no other "break" has occurred in the flower-color of Oenothera until mut. *vetaurea* appeared in my cultures during the past summer (1921). This mutation consists in a departure from the common citron yellow color typical of all wild species of this genus, to a color which ranges from Naples yellow (Ridgway) in the more distal portions of the petals, to slightly deeper shades in the same series of colors, in the center of the flower. The filaments and the distal portion of the stigmas are approximately primulinus yellow. The warmer tone in the center gives the flowers an aspect almost as if they were aglow with a light of their own.

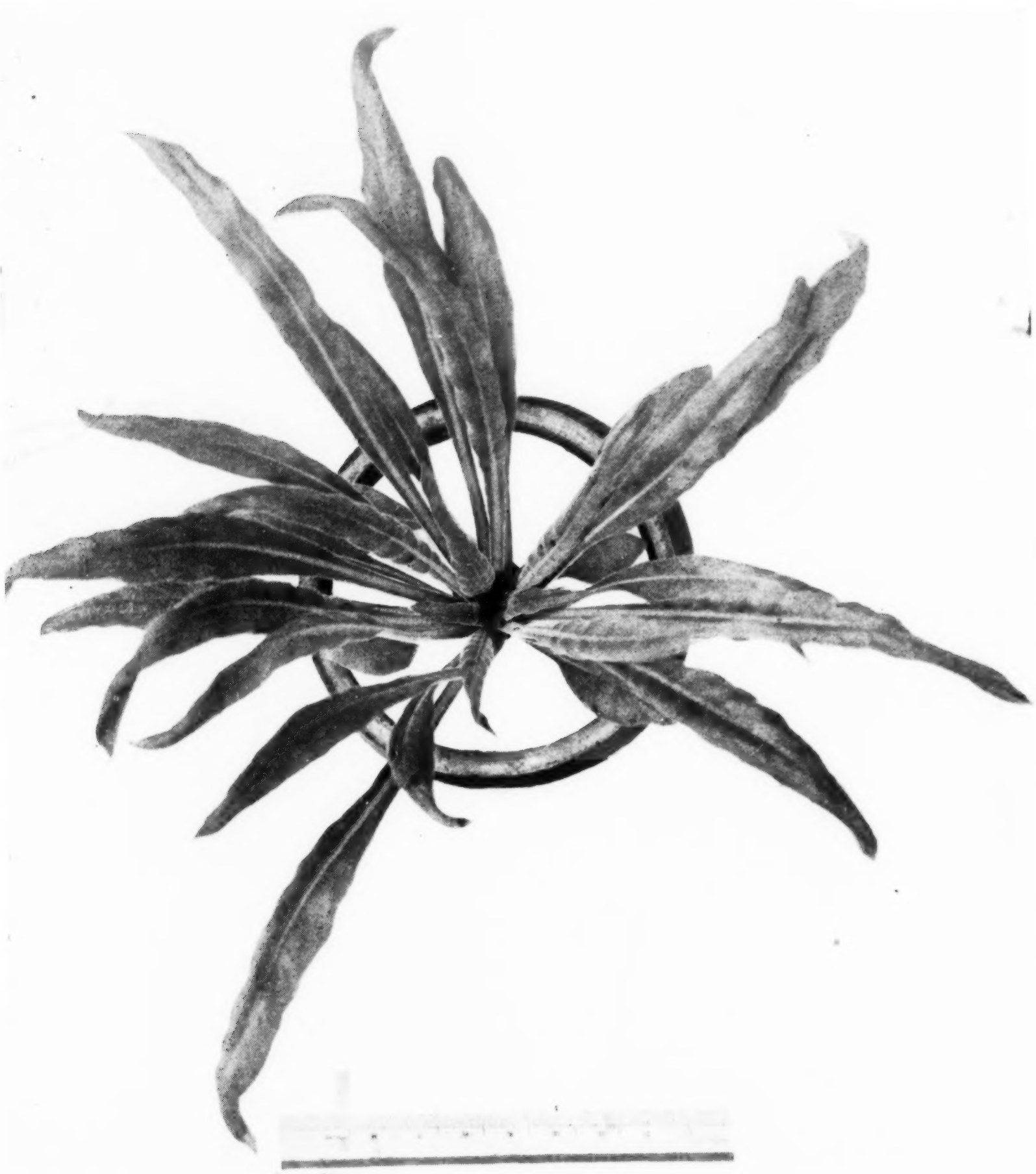
OENOTHERA LAMARCKIANA

Since the work of Professor Hugo De Vries with mutants of *Oe. Lamarckiana*, this plant has been extensively used by students of genetics. In the accompanying paper, Professor Shull describes three new mutants which have originated at Princeton, and which are likely to prove very useful. (Fig. 15.)

This beautiful mutation has appeared in two pedigree families (Nos. 2047 and 2052) which were progenies of two sibs in family No. 198 of my cross-bred strain of *Oe. Lamarckiana*, in 1920, and this fact makes it certain that the gene-mutation which made the realization of the *vetaurea* color possible occurred at least as early as 1919. Steps have been taken to test the extent to which the recessive *vetaurea* factor, *v*, is distributed in the cross-bred strain of *Oe. Lamarckiana* and the results of these tests should indicate whether the *vetaurea* gene-mutation probably occurred previously to 1919 or not.

Family 2052, in which *vetaurea* was first discovered, was the progeny of a typical specimen of *Oe. Lamarckiana*, and the single *vetaurea* specimen in this family was in all respects, except the color of the flowers, a typical pink-coned *Lamarckiana*. The other members of this family were all *rubricalyx*, being the F_1 of a cross between *Lamarckiana* and the characteristic homozygous aletha! segregate from *Oenothera rubricalyx*, which I call *Oe. latifrons*. Only an accident of technique which resulted in a self-fertilization of the mother plant made it possible for the *vetaurea* specimen to appear in this family.

The parent of 2047, the other family in which mut. *vetaurea* has appeared, was itself a mutation in the cross-bred *Lamarckiana* family 198. It differed from *Lamarckiana* in having the bud-cones nearly free from red pigment, and the stems a clearer green, but finely speckled with red papillae as in *Lamarckiana*. The capsules were a little less well developed and slightly more divergent than in *Lamarckiana*. One of the two zygote lethals characteristic of *Lamarckiana* was also wanting in this green-budded mutant as shown by the fact that family 2047, produced by self-fertilization, split into (a) the parent type, namely, green-budded near-*Lamarckiana*, and (b) near-*decipiens*,



POT-GROWN ROSETTE OF FUNIFOLIA

The conspicuously revolute development of the basal portions of the leaves is characteristic of this mutant. Photograph by James P. Kelly. (Fig. 16.)

in the ratio 62 : 32,—almost exactly the 2 : 1 ratio expected in such a case.

Vetaurea AND *sulfurea* POSSIBLY ALLELOMORPHIC

There were some losses of plants in this family by death, and a small number, especially of the slow-growing *decipiens* type, failed to bloom. Of those which bloomed there were in the (a) group 40 yellow : 13 *vetaurea*, and in the (b) group two yellow: seven *vetaurea*. While these numbers are too small to allow one to place any dependence on their validity as a measure of the relative positions of the factors involved, it will be noticed that they assume the form of a linkage ratio, which gives a preliminary hint that the *vetaurea* factor is in chromosome I where the characteristic zygote lethals occur, and the amount of crossing over between the lethals and the *vetaurea* factor seems to be about the same as that between the *sulfurea* factor and the lethals. It will not be surprizing therefore if the *vetaurea* factor should be found to be allelomorphic to the *sulfurea* factor. The necessary steps have been taken to test this and many other problems which the presentation of this new unit-factor has suggested. An alternative hypothesis regarding the relation of *vetaurea* color to yellow and sulfur is also being tested.

KITH AND KIN

ALEXANDER GRAHAM BELL
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IN DEALING with genealogical subjects I am much surprised at the poverty of the English language in words expressive of relationship.

We have no term to express generally the relation of one member of a family to another irrespective of sex. We speak of "brothers and sisters" but have no common term for the relationship intended, unless the rather clumsy word "siblings" recently proposed should become generally adopted.

We have no general term, irrespective of sex, for the relationship indicated by the words "uncle and aunt," nor have we any other word than "cousin" to express collateral relationship, and we use the term in the most vague way.

It is surely advisable, in dealing with genealogical subjects, to adopt a terminology that shall be clear, distinct and unambiguous.

I have hitherto employed a plan of designating the ancestors of an individual by numbers (2, 3, 4, 5, 6, etc.), even numbers representing males and odd numbers females (see JOURNAL OF HEREDITY for May 1921). While this method meets the wants of a scientific classification of ancestry, it does not fulfil the need for an ordinary terminology.

We often allude to our "kith and kin." We all have a pretty definite idea of what we mean by "kin,"—relationship through a common ancestor, our own kindred, our blood relatives; but what do we mean by "kith?" The word by itself is obsolete. Webster defines it as "acquaintance, intimate acquaintance and relationship."

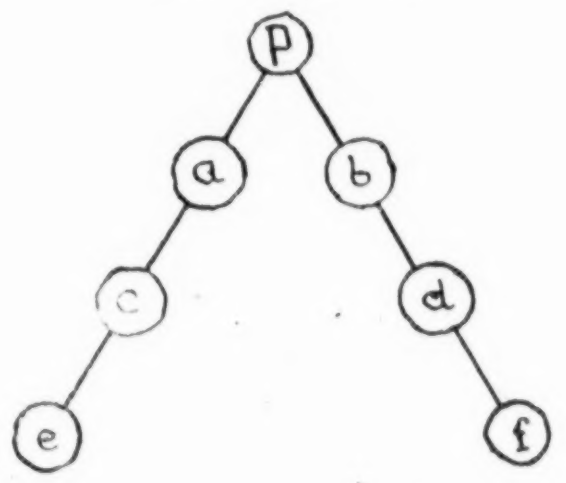
I think it would be a good plan to revive the term "kith" and give it the special meaning of relationship through a common descendant.

Kin:—Persons who have a common ancestor are kin.

Kith:—Persons who have a common descendant would be kith.

The following diagrams illustrate the proposed terminology.

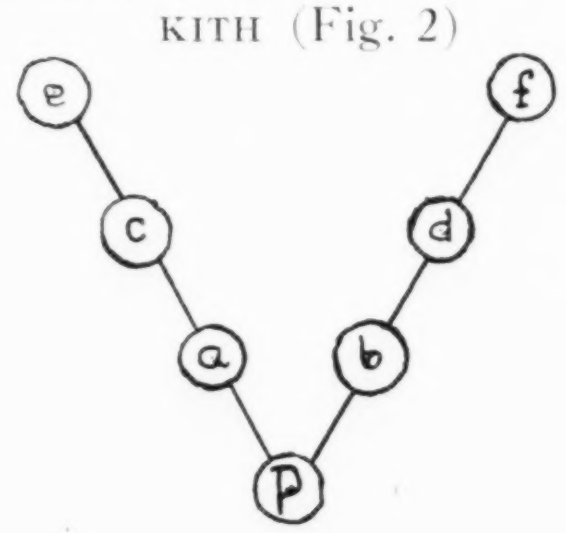
KIN (Fig. 1)



Kin:—All the descendants of the propositus *P* in the above diagram are kin to one another. *a* and *b* are first kin, *c* and *d* are second kin, *e* and *f* are third kin, and so on.

Under this terminology the members of a family (brothers and sisters) are first kin to one another by virtue of the possession of a common parent (either father or mother). Where the brothers or sisters, (*a b*) have the same father and mother they are doubly first kin to one another: or, perhaps, it would be better to say they are full kin, because all of their ancestors are the same in each case.

KITH (Fig. 2)



Kith:—All the ancestors of the propositus *P* in this second diagram are kith to one another. *a* and *b* are

first kith, *c* and *d* second kith, *e* and *f* third kith, etc.

Under this terminology husband and wife become first kith when they have a child, *P*. All of the four grandparents of the child *P* would be second kith, the eight great-grandparents would be third kith, the sixteen great-grandparents fourth kith, etc.

The word "kith" would thus mean more than mere "acquaintance." It would indicate a sort of indirect blood relationship. In the case of persons who are kith their blood mingles in their common descendant.

These definitions of kith and kin seem to me to be satisfactory as far as they are used to express the relationship of persons belonging to the same generation. The case changes, however, when you are dealing with persons in different generations, as "uncle and nephew," "first cousin once removed" etc. In such cases it may be necessary to specify the individual degree of relationship to the common ancestor or descendant. For example, uncle and nephew, *a* and *d* Fig. 1, are first and second kin through the common ancestor *P*, and first cousins once removed, *c* and *f* are second and third kin through the common ancestor *P*.

In the case of persons who are kith it would be the same thing reversed, the blood relationship would be through a common descendant. In Fig. 2, *a* and *f* would be first and third kith through the common descendant *P*, a relationship for which there is at present no name whatever.

Our terms for ancestors and descendants are also very clumsy and become impracticable of use when we get a few generations from the individual studied. The relation of ancestors is more quickly apparent if we speak of first parents, second parents, third parents, fourth parents, etc., than if we say parents, grandparents, great-grandparents, great-great-grandparents. The advantage is more and more obvious the farther we go from the *propositus*, *P*; for it is certainly simpler to speak of his sixth parents than of his great-great-great-great-grandparents.

The same terms could be used for descendants and instead of speaking of children, grandchildren and great-grandchildren we could say first children, second children and third children.

In a subject of such general interest as this it seems to me important that the terminology should be easily understood, and I hope that these suggestions will be of use in starting a discussion of the whole subject.

Foundations of Human Genetics

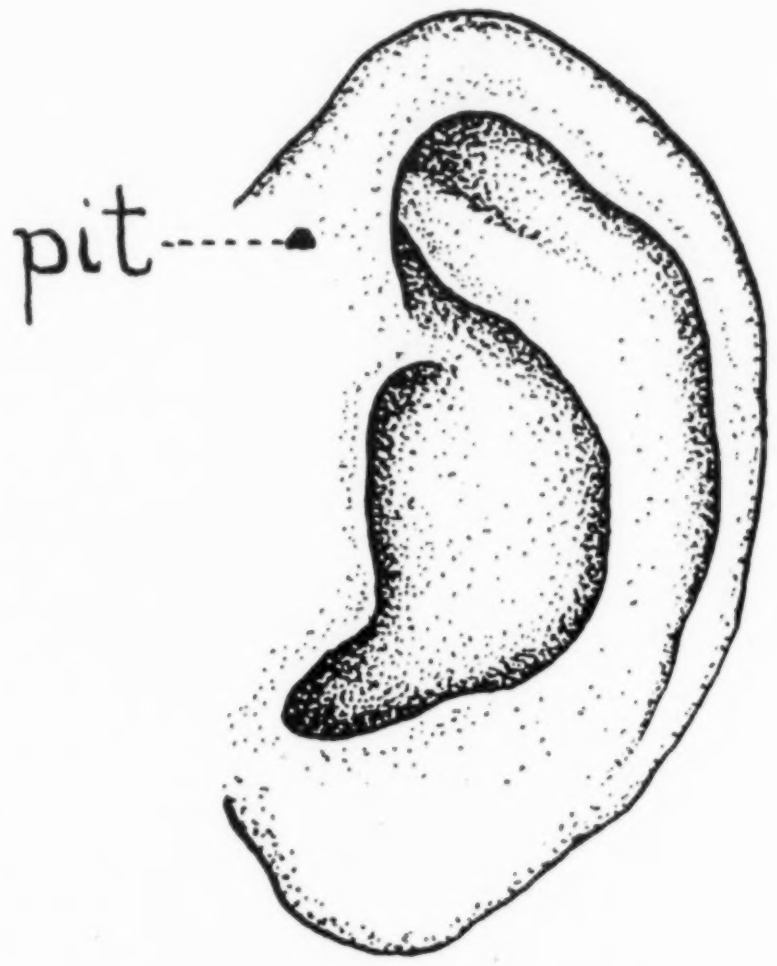
GRUNDRISS DER MENSCHLICHEN ERBLICHKEITSLEHRE UND RASSEN*-HYGIENE, Band I, Menschliche Erblichkeitslehre, von Prof. Dr. Erwin Baur, Prof. Dr. Eugen Fischer, u. Dr. Fritz Lenz. Mit 65 fig. im Text. J. F. Lehmanns Verlag, Muenchen, 1921, pp. 305.

Three scholars of recognized standing have united to put out this comprehensive work on eugenics and social hygiene. In the present volume Dr. Baur outlines the general principles of heredity and variation in the first part, while Dr. Fischer in the second part discusses racial differences in mankind. The third and fourth parts, by Dr. Lenz, are respectively devoted to the inheritance of tendencies to disease, and to the inheritance of mental traits. It is stated that the concluding volume, not yet published, will be entirely the work of Dr. Lenz, and will be devoted to "race hygiene." The present volume, which is compiled principally from continental sources, gives a good general picture of the subject. Dr. Fischer and Dr. Lenz confine themselves mainly to stating that certain traits are inherited, without discussing in detail the manner of inheritance.—P. P.

INHERITANCE OF A PIT IN THE SKIN OF THE LEFT EAR

JAMES ERNEST KINDRED
Biological Laboratory, Western Reserve University

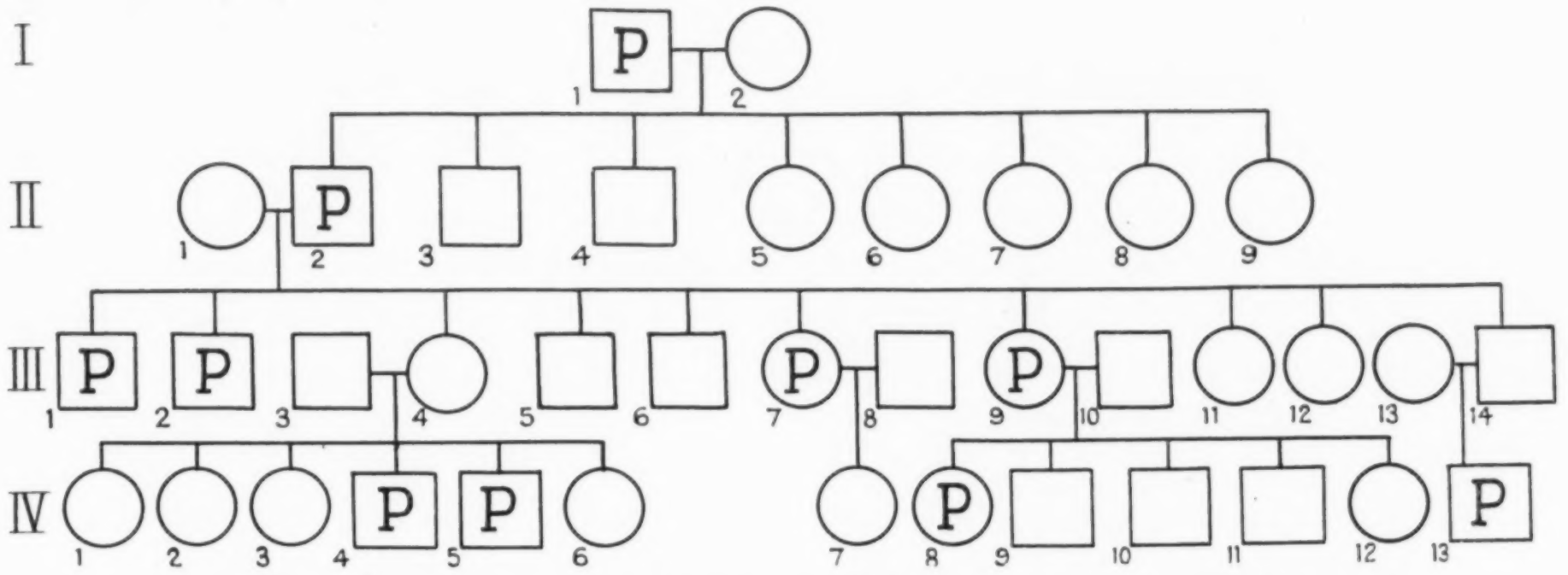
IN DISCUSSING the characteristics of the ears of a group of people in connection with Schofield's paper (1917) on the inheritance of the bi-lobed ear, one of the members of the group called attention to the fact that she had a bi-lobed ear, but did not know of such a condition in any of her relatives. Her mother then remarked that she had a peculiar pit on the side of her left ear. Upon examination of this ear, a small pit was observed in the skin of the proximal end of the upper part of the helix. The accompanying sketch shows its relative position. My informant then told me that this pitting was a distinctive mark in her family and by carefully questioning her, I learned the following interesting facts concerning the inheritance of this peculiar marking. A graphic summary of the inheritance of this pit is given in the chart on the opposite page.



Position of the inherited pit. (Fig. 17.)

As far as the propistus could recollect, the marking was first noted in her paternal grandfather (I, 1). Her father (II, 2), one of eight children, had the pitted condition, and although she did not know whether or not his sisters or brothers were so marked, it seems more than likely that they were, because some of her cousins had a pitted helix. In the third generation there were four individuals, 2 girls and 2 boys, with the pitted helix. The propistus (III, 7), is one of the girls, her daughter (IV, 7) does not have the pitted helix. The sister of the propistus (III, 9), also having the pitted helix, is married and has five children, one daughter (IV, 8) having the pitted helix. None of the boys with pitted helix in generation III, married. Another sister of the propistus (III, 4), not pitted herself, is married and has six children, two boys and four girls. Both of the boys (IV, 4, 5) have the pitted helix. A brother of the propistus (III, 14) does not have the pitted helix, but his only son has. The propistus states that in all cases the marking is on the same spot of the same ear (left).

Thus in this fraternity there is some factor inherited which has to do with the formation of the skin in the region of the proximal end of the helix. The pitting occurs in some individuals of each generation from the time of its appearance and may be transmitted by individuals not marked themselves. Further, it may be transmitted by either sex. In some cases the offspring of unpitted parents are pitted, while in other cases the pit does not occur in the offspring of a mating in which one or the other of the parents is pitted. Judging from the manner of its appearance, the marking is neither dominant nor recessive, but must fall into the intermediate doubtful class of incomplete dominance.



INHERITANCE OF PIT IN THE EAR THROUGH FOUR GENERATIONS

The propositus in this case is No. 7 in the third generation. Her grandfather (I, 1) was the first known to have the pitted condition. He transmitted it to his son (II, 2), father of the propositus. He (II, 2) passed it on to four of his children as shown in the third generation. Two others of the third generation, not possessing the pit themselves, transmitted it to individuals in the fourth generation. It may also be seen that III, 7 did not transmit the condition to the next generation, but that III, 9 did. (Fig. 18.)

A New Study of Eugenics

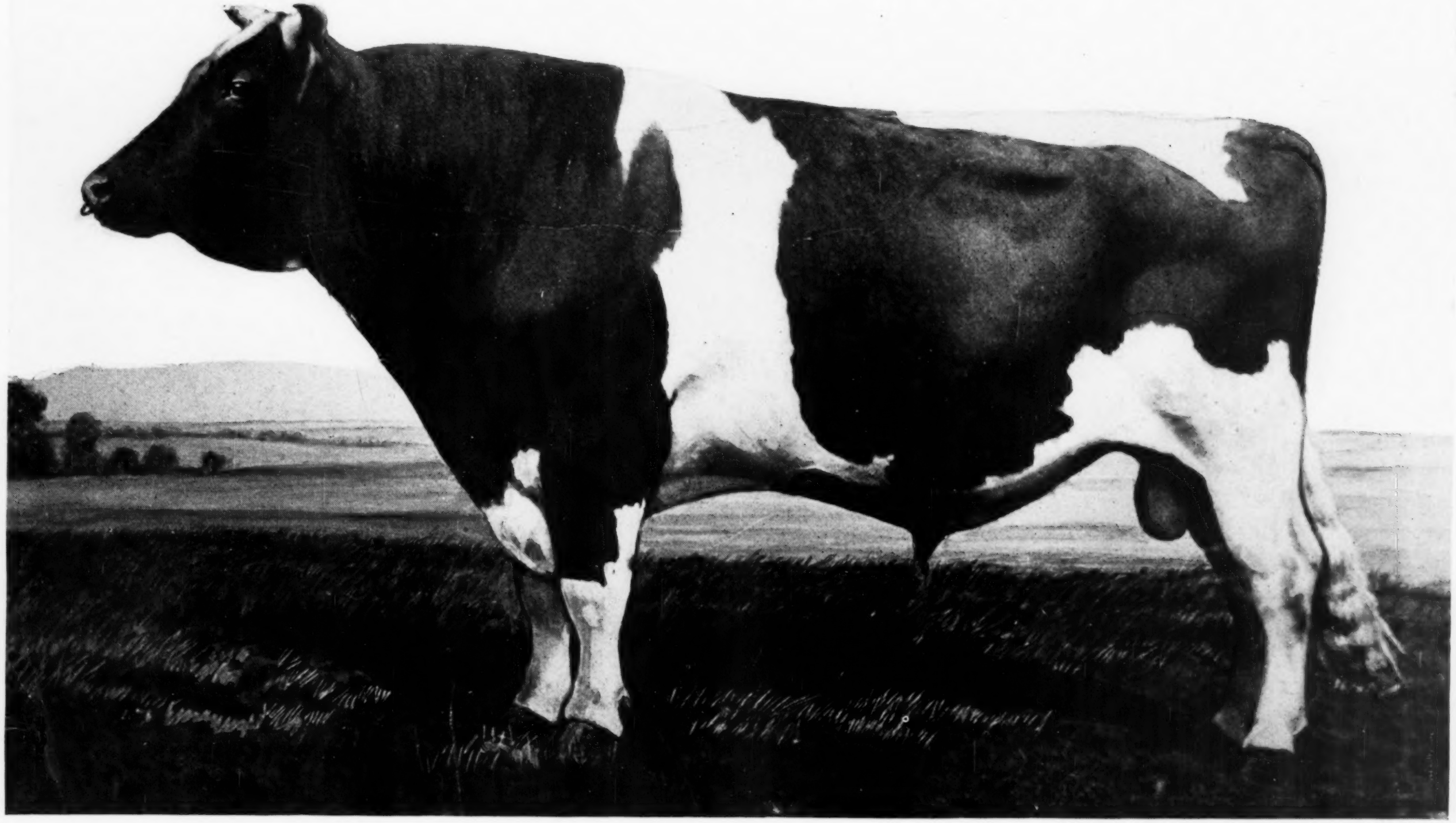
THE TREND OF THE RACE: a study of present tendencies in the biological development of civilized mankind, by Samuel J. Holmes, Ph.D., professor of zoology in the University of California. Pp. 396, price $4 net. New York, Harcourt, Brace & Co., 1921.

Never before have the data of eugenics been subjected to such a thorough criticism as by Dr. Holmes. Entirely in sympathy with the principles underlying the eugenics movement, he has made a valuable contribution to it by his exhaustive treatment of the literature, particularly that from Europe. His conclusions generally accord with those accepted by other eugenists. The book is lacking in careful definitions of the terms used, and makes little attempt to suggest remedies for the various dysgenic trends noted. After a few introductory chapters on inheritance, and on the birth rate, it is devoted almost wholly to a consideration of the various selective influences at work on mankind. It is announced that a full bibliography of the subject is to be published separately.—P. P.

For and Against Birth Control

THE CONTROL OF PARENTHOOD, edited by James Marchant, introduction by the Bishop of Birmingham. Pp. 222. New York and London, G. P. Putnam's Sons, 1920.

Every intelligent person favors birth control—in one sense or another; but most intelligent persons reprobate the birth-control propaganda which has been a glaringly unscientific treatment of a biological subject. In this volume the problem is discussed by J. Arthur Thomson, Leonard Hill, Dean Inge, Harold Cox, Mary Scharlieb, F. B. Meyer, A. E. Garvie, H. Rider Haggard and Marie C. Stopes, some being pro, some being contra, and one or two apparently "on the fence." The volume probably presents the sanest and most thoughtful discussion of the subject that is available, although the rhapsodical views of Dr. Stopes on "maternal impressions" hardly belong in a serious book. While nothing new is presented, the facts and arguments on both sides are brought forward in a way that should stimulate any responsible person to do a good deal of thinking, if his mind is not already closed on this topic.—P. P.



ONE OF THE FOREMOST SIRES OF THE HOLSTEIN-FRIESIAN BREED, SIR PIETERTJE ORMSBY MERCEDES (44931)

This sire has fourteen daughters with records of over 1000 pounds of butter (80% fat). Sixty-one of his daughters in the Advanced Register have records that average 17,816.29 pounds of milk, 3.6%, containing 641.38 pounds of fat. Sir Pietertje Ormsby Mercedes may be termed an out-cross sire, his parents being unrelated. "The genealogy table shows very clearly that this animal was not developed on the hit and miss plan, but that his ability to transmit high production is caused by the bringing together of blood lines that are noted for their production and their ability to transmit this production." (Fig. 19.)

SELECTING HOLSTEIN-FRIESIAN SIRES FOR HIGH YEARLY PRODUCTION

A Detailed Study of the Records of 1478 Registered Animals Proving the Value of Certain Blood Lines in Transmitting High Production

R. E. HUNT
Virginia Agricultural Experiment Station, Blacksburg

SUCCESS in the dairy business depends very largely upon average production of the cows that are in the milking herd. The average of all dairy cows in the United States is very much below what it should be. The function of the improved dairy breeds is to increase this low average to a very much higher average.

The breeder of purebred dairy stock seeks to raise the best producers possible in order that his milking herd may reach a very high level of production. Males from the purebred herd may be sold to dairymen with grade or purebred milking herds with the result that the production of their heifers from this registered sire will be quite superior to their dams. In order to assure success in breeding the above mentioned stock, it is necessary to have some definite method of making the proper selection of the females, and especially the herd sire. This means that we must have some method of locating the leading blood-lines of the breed and the possibilities of the sire selected proving his prepotency for average high production.

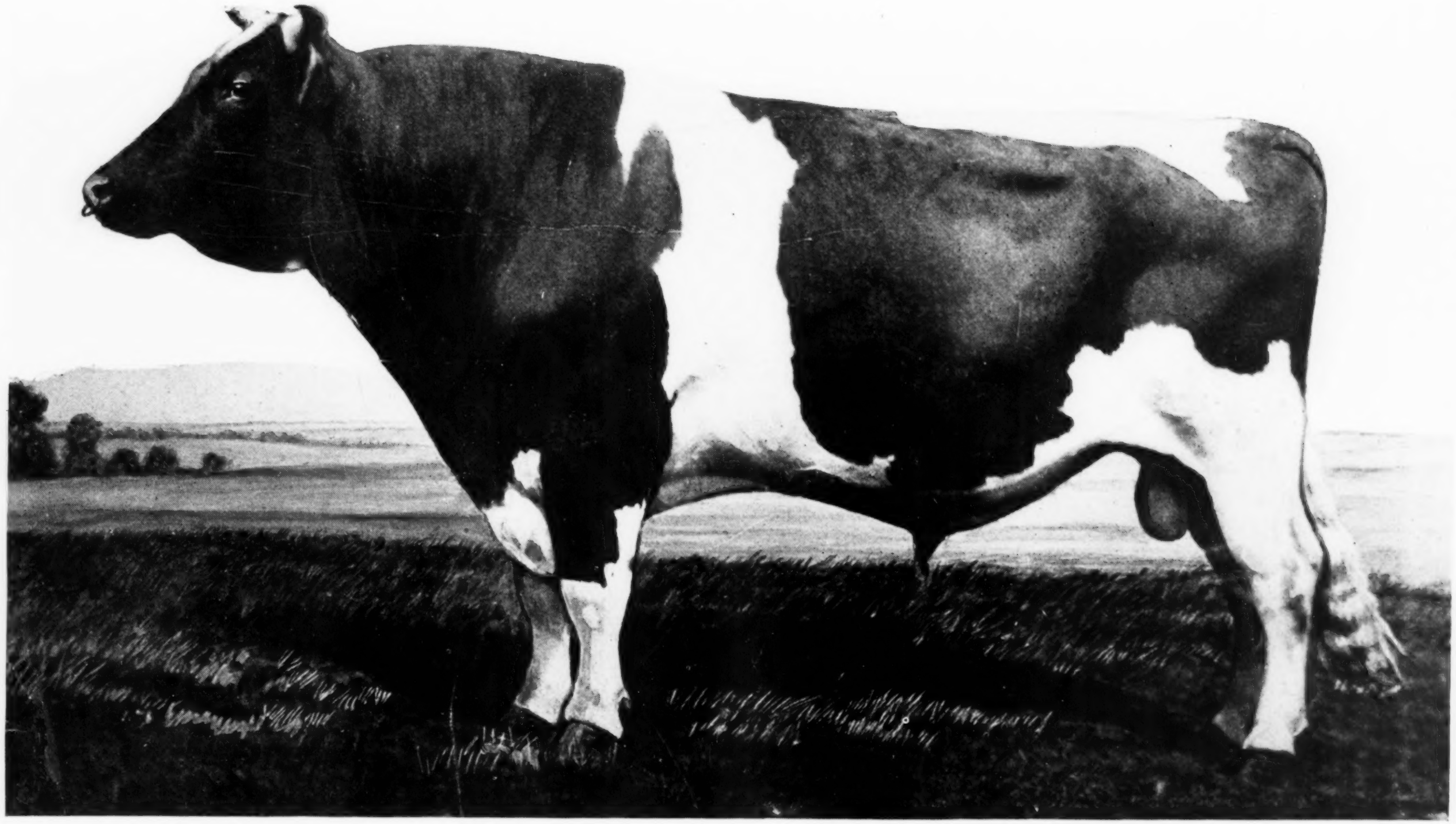
Of course, most dairymen and purebred breeders will select young untried sires. This means that their sire's future will be judged entirely by the records of his ancestors. The Blue Books of the Holstein-Friesian Association of America give a great mass of very valuable material, but it does not show the lines of greatest production or the way this lineage transmits high production. This paper is an attempt to show the lineage of highest production and how it is transmitted down through the various generations.

METHODS OF ESTIMATING RECORDS

The data reported in this paper was taken from volumes 24 to 30 inclusive of the official Blue Book and Herd Books of the Holstein-Friesian Association of America. The pedigrees of all cows having yearly records equivalent to or greater than 600 pounds of butterfat were tabulated for three generations, and all cows having yearly records equivalent to or greater than 800 pounds of butterfat were tabulated for five generations.

Yearly records were chosen for the basis of this study because the dairyman milks his cows twelve months in the year and wants to know what he can expect from the daughters of the herd sire of his selection.

The records of all cows used were made comparable by estimating the amount of butterfat produced by all cows under five years on the basis of the yearly requirements. For the lack of better and more authentic information, it was assumed that the requirement of 250.5 pounds of butterfat for a heifer freshening at the age of two years or less, increased by (.1) one-tenth of a pound of fat for each day over two years until the age of five years is reached, when the cow is considered mature and the required production is 360 pounds of fat. The record of a heifer freshening at the age of two years and no days and producing 500 pounds of fat would be considered equivalent to a 718.4 pound mature record. The number of pounds of fat produced times 360, the requirement for a mature cow, divided by the



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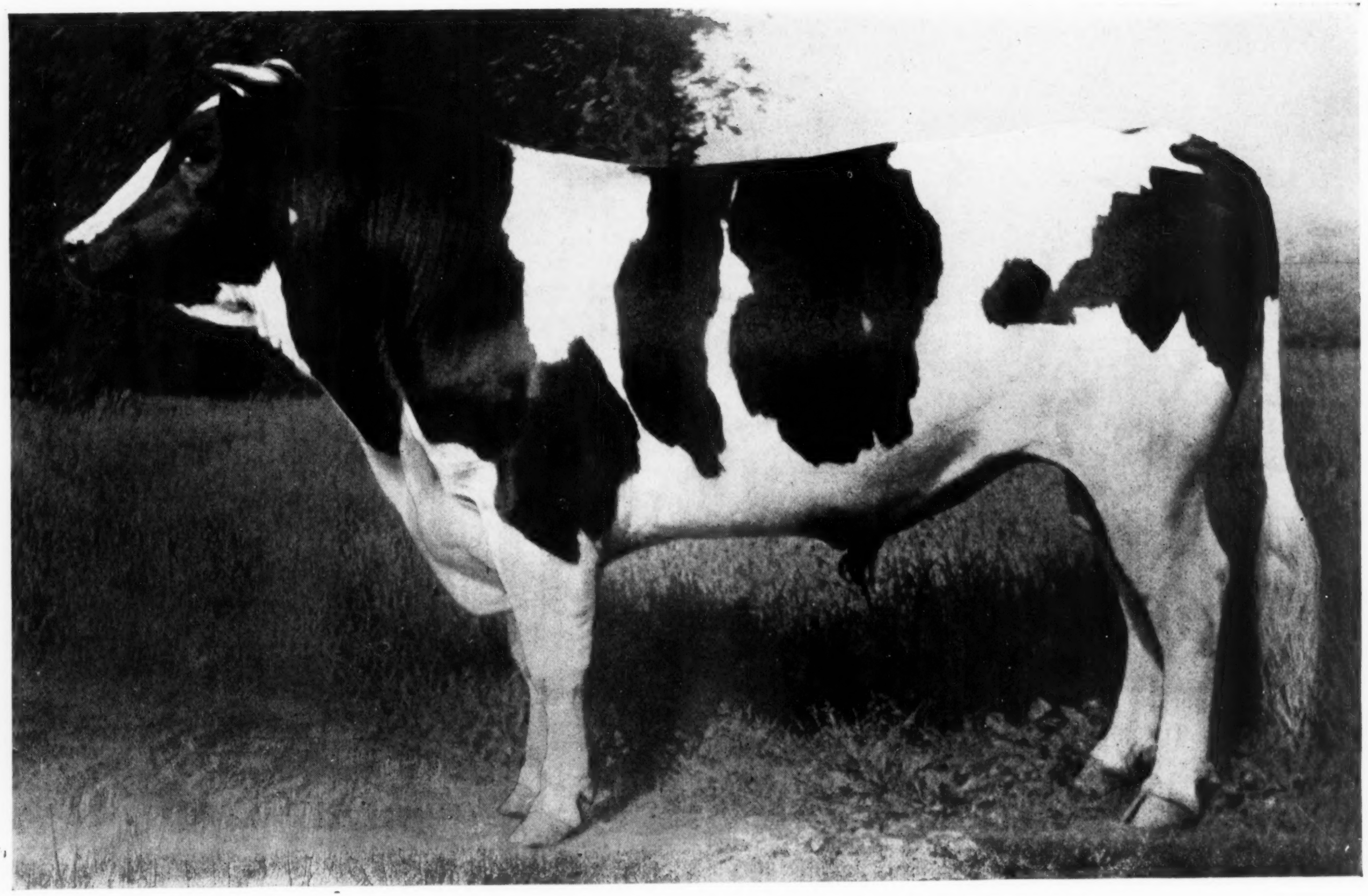


KING OF THE PONTIACS, ANOTHER HOLSTEIN-FRIESIAN LEADER

A few years ago, this sire was considered one of the leading representatives of his breed. His sire, Pontiac Korndyke, is one of the greatest of the Holstein-Friesians. Aside from having a large number of daughters that have made large seven day and yearly records, King of the Pontiacs has also some great breeding sons, such as King Pontiac Champion and Spring Farm King Pontiac. King of the Pontiacs resulted from the mating of unrelated parents. A study of the pedigrees of this and the other sires listed in this paper shows that "they are the result of a wise selection of sires in the improvement of the individual or the herd." (Fig. 20.)

requirement of the heifer at the age of freshening, or in this case,

$$500 \text{ lbs. fat} \times \frac{360 \text{ requirement for mature cow}}{250.5 \text{ requirement for heifer at 2 years}} = 718.4 \text{ lbs. fat}$$

or the amount of butterfat this heifer would produce if she were mature, handled under similar conditions and had not been injured before she reached maturity. This method of estimating records may not be absolutely correct, but that point will not be debated. This much can be said in its defense: It is based on the requirements of the American Jersey Cattle Club, the Guernsey Breeders' Association, the Ayrshire Breeders' Association, and the Holstein-Friesian Association of America for admittance for yearly records.

TABLE I: *Advanced Registry Requirements for 600 lbs. Standard*

Class	Reg. Req.	600 lbs. Standard
Mature	360.00	600.00
Senior 4-year-old	341.75–360.00	569.58–600.00
Junior 4-year-old	323.50–341.75	539.17–569.58
Senior 3-year-old	305.25–323.50	508.75–539.17
Junior 3-year-old	285.00–305.25	475.00–508.75
Senior 2-year-old	268.75–285.00	447.91–475.00
Junior 2-year-old	250.50–268.75	417.57–447.91

The standards of 600, 800 and 1000 pounds of butterfat were selected because any cow producing over 600 pounds or its equivalent is a high producing cow and her producing qualities have been highly developed. The sire of five or more 600 pound daughters shows exceptional prepotency for producing high producing daughters. The 800 pound or its equivalent group was made to show exceptionally high production. Any cow in this list is a great cow, and any sire with two or more 800 pound daughters must transmit exceptional producing qualities. The 1000 pound or its equivalent group are composed of the breed's greatest producing cows. Any sire with a 1000 pound daughter should be considered among the breed's best sires. The divisions were made to determine the sires that produced the greatest producing daughters and the blood lines of these great sires.

From Table II it will be noted that the number of animals in each

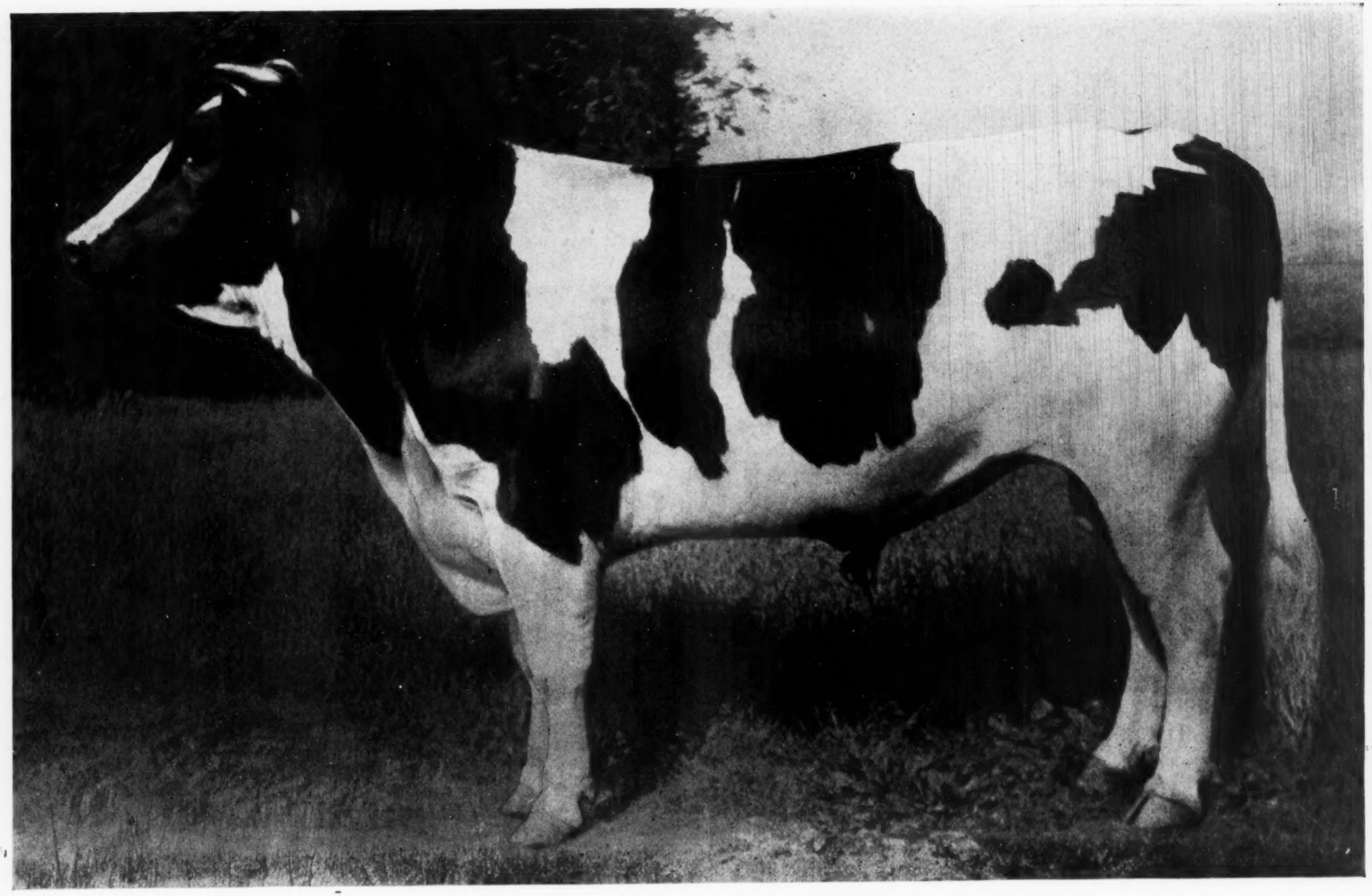
TABLE II: *1201 Cows Classified as to Equivalent Production, With Number in Each Group and Average Per Cent of Fat*
(Data do not include records found in Volume 30)

Fat Production	Over 1100 lbs.	1000 to 1100 lbs.	900 to 1000 lbs.	800 to 900 lbs.	700 to 800 lbs.	600 to 700 lbs.
Number of cows	6	31	80	167	280	637
Average % fat	4.32	3.88	3.63	3.54	3.63	3.44
Maximum % fat	4.53	4.64	4.59	4.47	4.48	4.40
Minimum % fat	3.68	3.18	2.92	2.81	2.56	2.57

group, except the one over 1100 pounds fat or its equivalent, has sufficient numbers to give definite results. Beginning with the average per cent fat for the cows with a production of from 600 to 700 pounds fat, or its equivalent, 3.44 per cent, it gradually increases, except the cows in the 700-800 pound fat class, and the same as that for the cows in the 800-900 pound fat class, and the same as that for the cows in the 900-1000 pound class. The maximum test, 4.64 per cent fat, was for a cow producing over 1000 pounds fat or its equivalent. The minimum test of 2.56 per cent fat was the lowest of any really high producing cow and it may be safely said that it is practically impossible for a cow to make over 1000 pounds fat or its equivalent unless the average test is at least 3 per cent fat.

Table III gives a list of sires having one or more equivalent to 1000 pound butterfat daughters, there being 52 daughters that will qualify for this list. King Segis Pontiac Count with 29 Advanced Registry daughters, is the sire of five daughters with a yearly production of 1000 pounds butterfat or its equivalent, a most wonderful showing for his ability to transmit extremely high production. King Hengerveld Aaggie Fayne, with 34 Advanced Registry daughters, has three 1000 pound daughters. Six other sires have two daughters each, and the remaining thirty two 100 pound daughters each have a different sire, bringing out the fact that no one particular sire has produced all the extremely high record cows, and that of the total 52 more than half of them are sired by animals with only one extremely high record daughter.

While the blood lines of these animals are very closely related, by studying the



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Minimum % fat	3.68	3.18	2.92	2.81	2.56	2.57

group, except the one over 1100 pounds fat or its equivalent, has sufficient numbers to give definite results. Beginning with the average per cent fat for the cows with a production of from 600 to 700 pounds fat, or its equivalent, 3.44 per cent, it gradually increases, except the cows in the 700-800 pound fat class, and the same as that for the cows in the 800-900 pound fat class, and the same as that for the cows in the 900-1000 pound class. The maximum test, 4.64 per cent fat, was for a cow producing over 1000 pounds fat or its equivalent. The minimum test of 2.56 per cent fat was the lowest of any really high producing cow and it may be safely said that it is practically impossible for a cow to make over 1000 pounds fat or its equivalent unless the average test is at least 3 per cent fat.

Table III gives a list of sires having one or more equivalent to 1000 pound butterfat daughters, there being 52 daughters that will qualify for this list. King Segis Pontiac Count with 29 Advanced Registry daughters, is the sire of five daughters with a yearly production of 1000 pounds butterfat or its equivalent, a most wonderful showing for his ability to transmit extremely high production. King Hengerveld Aaggie Fayne, with 34 Advanced Registry daughters, has three 1000 pound daughters. Six other sires have two daughters each, and the remaining thirty two 100 pound daughters each have a different sire, bringing out the fact that no one particular sire has produced all the extremely high record cows, and that of the total 52 more than half of them are sired by animals with only one extremely high record daughter.

While the blood lines of these animals are very closely related, by studying the

HOLSTEIN-FRIESIAN COWS ON A VIRGINIA FARM

"Success in the dairy business depends very largely upon the average production of the cows that are in the milking herd." This paper shows, by presenting the lineage of certain well established families, how "well bred animals of good invidiuality are essential to successful breeding" for high milk and butterfat production. Yearly records form the basis of the study, and it is noted how certain blood lines are responsible for the greatest records of production. Photo by L. W. Beeson. (Fig. 21.)

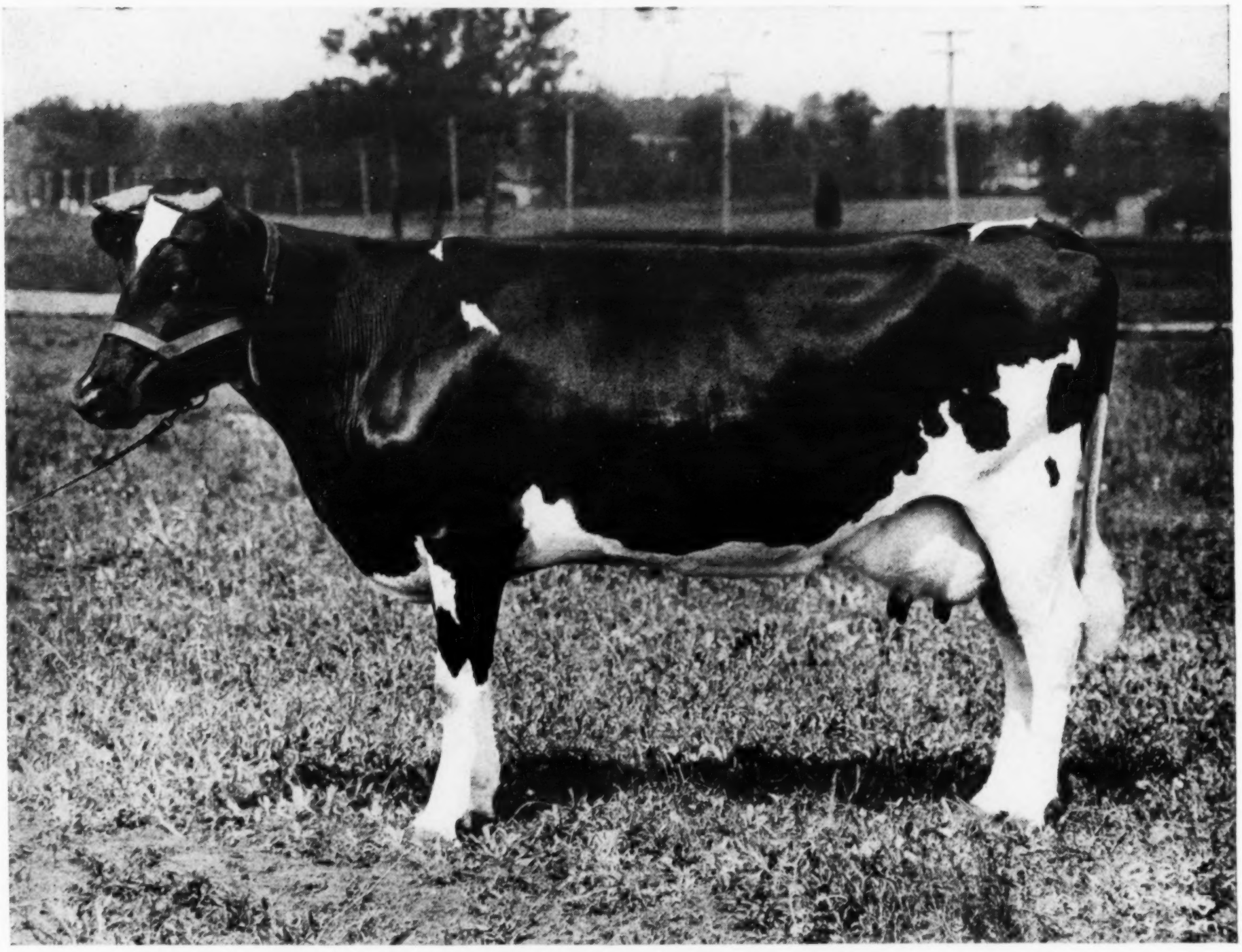
genealogy table which follows it will give you the relationship of these sires, showing that they virtually all fall into three well defined families, with various sub-branches.

In studying the pedigree of King Segis Pontiac Count, it will be noted that he combines the blood lines of King Segis Pontiac Korndyke, and Hengerveld DeKol, and that these three individuals represent three of the greatest sires that brought about early improvement in the Holstein-Friesian breed in America. Practically all the sires found in this pedigree are noted for the production of their daughters and their ability to tramsmit production down through the various generations.

Table IV gives the sires having two or more daughters with records equivalent to or greater than 800 pounds Three hundred and seventy-two cows have a production equivalent to or greater than 800 pounds, but in the list of sires with two or more daughters there are only 58. Sir Pietertje Ormsby Mercedes heads this list with 16 daughters, King of the Pontiacs is second with 14, King Segis Pontiac Count is third with 12. Pontiac Aaggie Korndyke has 9, King Pontiac Champion 8, and Sir Johanna Piebe has 7. Two sires have 6 daughters each, two have five, four have 4 daughters each, 14 sires have 3 daughters each, 30 sires have 2 daughters each, and the remaining 166 cows with high production are sired by different individuals.

This again brings out the fact that no one particular sire has a monopoly on all the really high producing daughters, and that 166 sires have been able to produce one such daughter, but no more. When we consider that only 58 sires have qualified for this list, it gives us some idea of the value to be placed upon the animals found in this list, and the wonderful records of their daughters, as well as their ability to transmit high production. This is more forcibly brought out when one studies the genealogy table, tracing out the blood lines and relationship of these sires It is seen that these sires are found in the same blood lines as the list of sires with 1000 pound daughters, and in fact are so closely related that it would be impossible to draw a line or show any distinction between the blood lines of one group and the other.

Table V is made up of sires having five or more daughters with records equivalent to or greater than 600 pounds butterfat. Sir Pietertje Ormsby Mercedes heads this list with 42 daughters, King of the Pontiacs is second with 25, King Pontiac Champion is third with 22, Dutchland Colantha Sir Inka is fourth with 19, Sir Johanna Fayne with 17 is fifth. Another sire has 14 daughters, three sires have 13 each, one has 12, one 11, four have 10, six



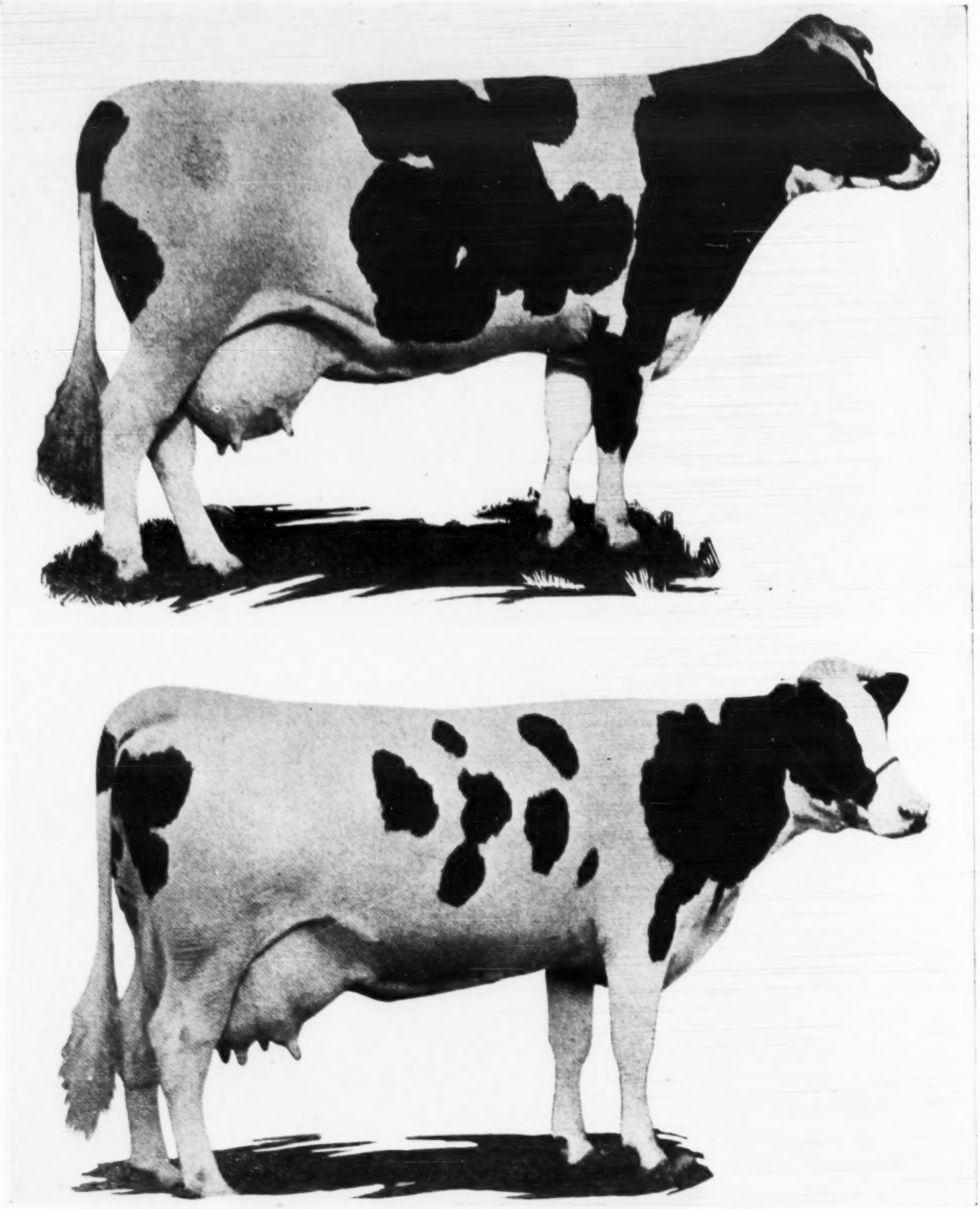
LONE STAR PONTIAC SEGIS (239068)

A daughter of King Segis Pontiac Count, owned by the U. S. Bureau of Animal Industry. Her record at the age of four years and two months was 21,355.3 pounds of milk, containing 680.33 pounds of butterfat. A daughter of this cow, by the unrelated sire, Piebe Laura Ollie Homestead King, 110474, has a record at the age of two years and one month of 16670.7 pounds of milk, containing 498.33 pounds of fat. A daughter of this latter cow, grand-daughter of Lone Star Pontiac Segis, and sired by a son of King Segis Pontiac Count, has a record at the age of two years and two months of 14,319.6 pounds of milk containing 445.22 pounds of fat. Photo from U. S. Dept. of Agri. (Fig. 22.)

have 9, five have 8, five have 7, four with six daughters, seventeen with 5 daughters each, twenty-seven have 4 daughters each, forty nine have 3 daughters, one hundred and six have 2 daughters each, and 999 have one daughter each, with a p oduction equivalent to or greater than 600 pounds butterfat.

This list of sires is very similar to those found in Tables III and IV. By referring to the genealogy table, you will note that they are very closely related, and that this fact is brought out very clearly that it is important, in selecting a herd sire, to select one from a lineage where there is uniformly high production. The mere fact that a sire has one high producing daughter does not mean that he is going to transmit high production to all his offspring. In this study, every sire listed undoubtedly has the ability to transmit high production to his offspring.

In studying the genealogy table, it brings out most forcibly that certain blood lines are capable of transmitting high production, and that certain other blood lines, not included in this genealogy table, are not capable of such production. It is unreasonable its believe that other families or blood lines have not been in the hands of good dairymen who understand feeding, and who gave their cattle good attention and the opportunity to make high records, but we do not find these in-



TWO WORLD'S CHAMPION MILK PRODUCERS

Both are daughters of the famous sire, King Segis Pontiac Count. The one at the top is Jewel Pontiac Segis (H.B. 229a61), three years old at the time of the photograph. Her record then for butter, one year, was 1,171.15 pounds, and milk, one year, 27,068.5 pounds. The lower photograph is of Beauty Beets Walker Segis (H.B. 290163), whose record of butter production for one year is 1,040.83, and milk 25,343.3 pounds. (Fig. 23.)

dividuals in the lists of actual high records of production.

If this paper brings out any one thing it is the fact that certain well established families can transmit high production and that certain other families cannot.

In studying the pedigree of Sir

Pietertje Ormsby Mercedes, and comparing it with the genealogy table, it shows very clearly that this animal was not developed on the hit and miss plan, but that his ability to transmit high production is caused by the bringing together of blood lines that are noted for their production and their ability to transmit this production. Practically every sire found in this pedigree can be located in the genealogy table, and it is the bringing together of such blood lines that makes a really desirable sire.

One of the most encouraging features of the study of the pedigrees of Sir Pietertje Ormsby Mercedes, King Segis Pontiac Count, and King of the Pontiacs—and in fact, almost any sire found in these lists,—is the fact that they are the result of a wise selection of sires in the improvement of the individual or the herd. By going back 4, 5, or 6 generations, the females have nothing particular to make them great individuals, but by the continual use of really high class sires, wonderful individuals have been developed, and it brings out the importance of a good sire used upon ordinary individuals and the possibility of increasing the production of the herd by the wise and proper selection of sires.

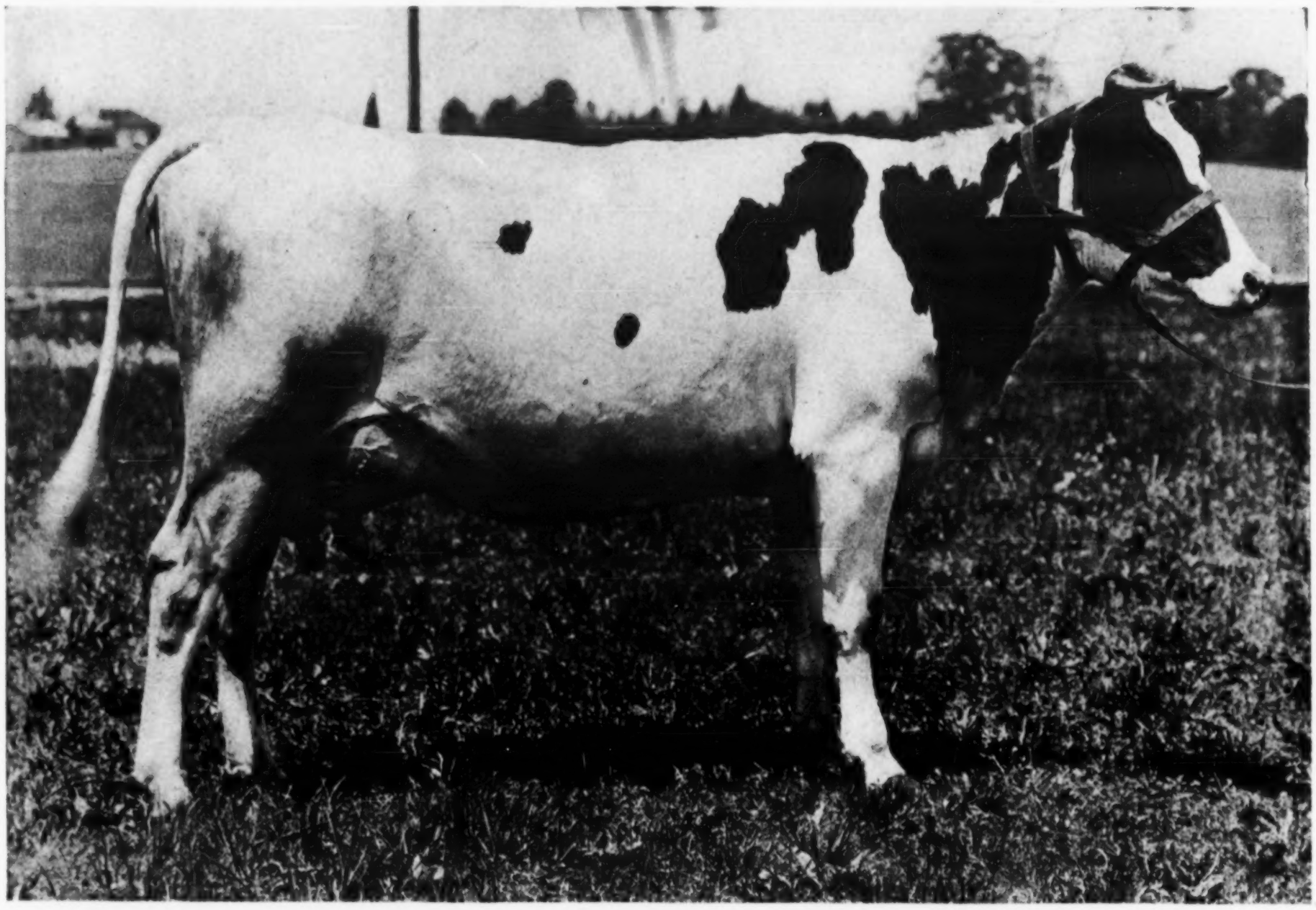
METHOD OF READING NUMBERS IN TABLE VI

The first figure in the parenthesis indicates the number of the sire's Advanced Registry daughters; the second figure, the number of sons that he has that are sires of tested daughters; the third figure; the number of daughters that are dams of tested daughters; the fourth figure, the number of his daughters that have produced the equivalent to or more than 1000 pounds of butterfat; the fifth figure, the number of his daughters that have produced the equivalent to or more than 800 pounds of butterfat; the sixth figure, the number of his daughters that have produced the equivalent to or more than 600 pounds butterfat. All daughters with a production equivalent to or greater than 1000 pounds butterfat are included in the number of equivalent to or greater than 800 pounds butterfat, because it is a production greater than 800 pounds butterfat. In the equivalent to or greater than 600 pounds butterfat class, the number includes all daughters with a production equivalent to or greater than 600 pounds.

METHOD OF READING TABLE VI

Table VI should read as follows: Sir Henry of Maplewood is the sire of two sons that are sufficiently important to be considered in this table, namely, Mechthilde Sir Henry of Maplewood and Sir Mechthilde of Maplewood, as indicated by the line dropping straight down and the names of the sons slightly indented. In the same way, Mechthilde Sir Henry of Maplewood is the sire to two sons, Tirania's Sir Mechthilde and Empress Josephine 3d Sir Mechthilde, who is the sire of Manor Josephine DeKol, who, in turn, is the sire of Pontiac Korndyke. Pontiac Korndyke has three sons in the preceding lists, namely, King of the Pontiacs, Pontiac Aaggie Korndyke, and Pontiac Hesseltje Korndyke. King of the Pontiacs has three sons listed, King Pontiac Champion, Spring Farm King Pontiac, and Cornucopia Pontiac Johanna Lad. In the second column it will be noted that King Segis has nine sons in the preceding lists, King Segis Pontiac, King Segis Hengerveld Vale, Sir Ormsby Burke Segis, Sir Walker Segis, Walker Korndyke Segis, and DeKol Beets Segis. King Segis is sired by Mercedes Julip's Pietertje Paul, who in turn is sired by Johanna Rue 2d's Paul DeKol, he by Paul Mutual DeKol, the son of Paul DeKol. Where a sire has only one son, that animal is placed immediately below his sire and slightly to the right. Where a line is dropped down it indicates that a sire has more than one son in the preceding lists. The number of sons listed are all numbered and are attached to the same perpendicular line.

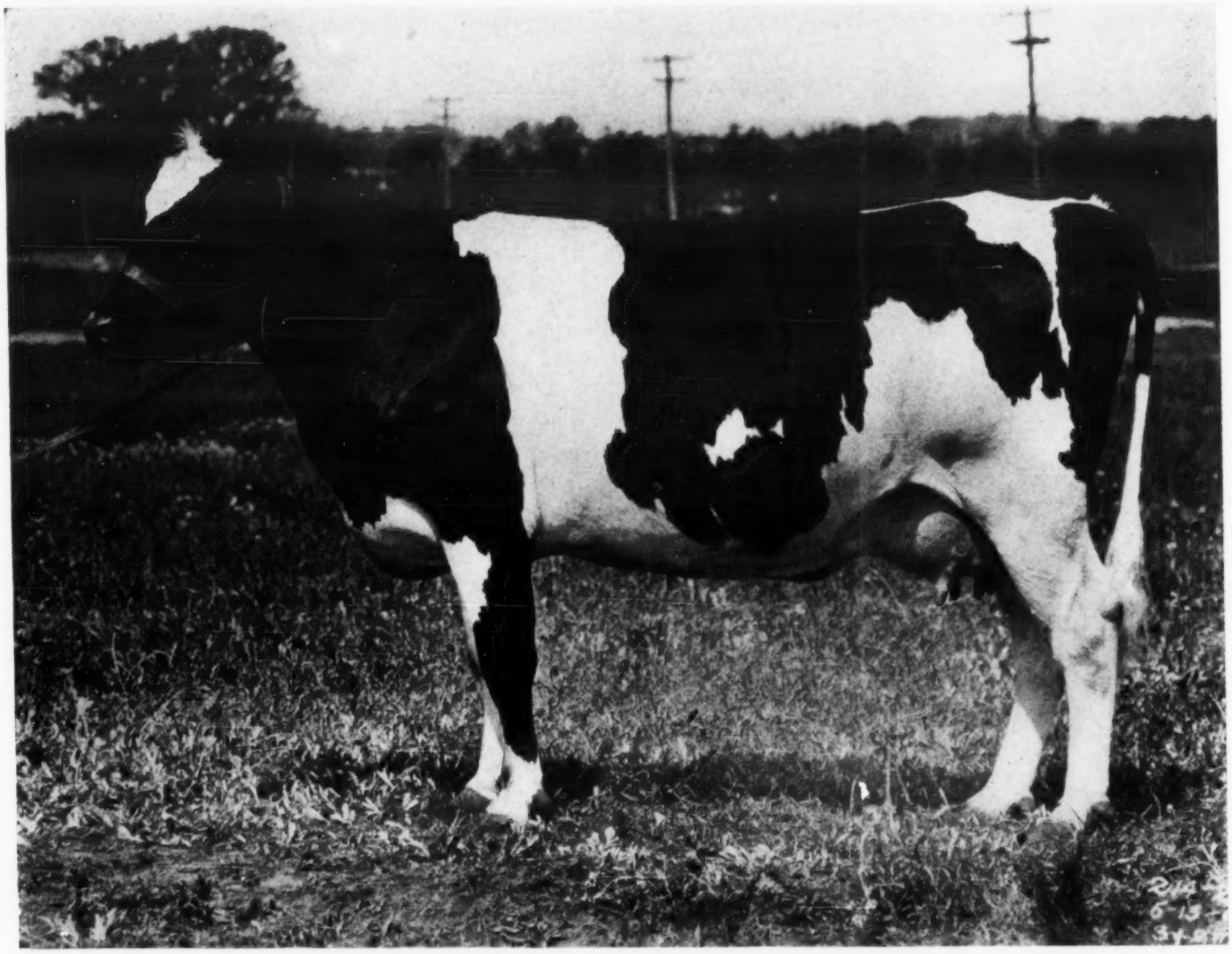
Table VI gives the genealogy of ALL



A WORTHY DESCENDANT OF NOTABLE ANCESTORS

Johanna De Kol Concordia (310231) is owned by the U. S. Bureau of Animal Industry. Her record made at the age of three years and seven months is 19,036.7 pounds of milk, containing 671.2 pounds of fat. Her sire is a son of Sr. Fayne Concordia who traces in a direct male line to the great foundation sire, Paul De Kol, and out of Ona Clothilde De Kol 2nd, who has a record of 835 pounds of fat at the age of nine years and six months, and has a daughter with a record of 1013 pounds of fat. Ona Clothilde De Kol 2nd's mother is the great cow Ona Clothilde De Kol who has a record of 876 pounds of fat at eleven years and ten months of age, and heads a four generation group of female descendants in which each one has a record exceeding 800 pounds of butter fat. Photo from U. S. Dept. of Agri. (Fig. 24.)

the famous Holstein-Friesian sires when based on the performance of their offspring in making high yearly records. One of the striking features is the influence of the wonderful cow, DeKol II. This cow was bred to Sir Abbekerk and produced DeKol II Butter Boy, and it is from this lineage that we get such famous sires as Hengerveld DeKol, Sir Hergerveld Model Johanna, and Sir Hergerveld DeKol. When Neptune Jr. was bred to DeKol II, they produced DeKol II Prince, the sire of Paul DeKol, and it is from this lineage that we get such famous animals as Segis, King Segis Pontiac Count, Ignaro DeKol, King Mead of Riverside, Sir Johanna Piebe, Sir Veeman Hengerveld, and many other wonderful producing sires. Thus, when Paul DeKol was bred back to his grandam, DeKol II, this union produced DeKol II Paul DeKol, and from this lineage we have such animals as Sir Homestead Skylark and Canary Paul. When Netherland Alban was bred to DeKol II they produced DeKol II Netherland, and from this lineage we have Manor DeKol, and Korndyke Queen DeKol's Prince. When Manor DeKol was bred to his grandam, DeKol II, they produced DeKol 2d Butter Boy 3d. DeKol 2d Butter Boy 3d is the sire of such wonderful bulls as Friend Hengerveld DeKol Butter Boy, Hygeia Veeman Butter Boy, and from this lineage if high producing sires, coming directly from DeKol II, we have the wonderful sire, Sir Henry



A PRODUCT OF CAREFULLY SELECTED MATINGS

Lady Colantha Walker (365573) has a record of 17,843 pounds of milk, 546 pounds of fat, at the age of two years and two months. The top male line of her pedigree for five generations shows an unbroken line of great breeding sires, at the head of which is Sarcastic Lad, through whose sons have come some of the best producing strains of this breed. In addition to their ability to transmit high production, the value of the sires may be seen in the records of their daughters. (Photo from U. S. Dept. of Agri.) (Fig. 25.)

of Maplewood, which transmits down through one line, Pontiac Korndyke, the sire of King of the Pontiacs, while down through the second lineage, Jack Mercedes, the sire of Sir Pietertje Ormsby Mercedes. This family is very closely related to the DeKols. In fact, the different lines have been interbred a great deal, and it is hard to state which lineage has produced the most wonderful results.

Another line of breeding is the Sarcastic Lad, which is distantly related to Netherland Prince, the founder of the Manor DeKol line if breeding, including such wonderful sires as DeKol 2d Butter Boy 3d. From the Sarcastic Lad line of breeding comes such famous animals as Holmstead Girl DeKol Sarcastic Lad, Woodcrest Tehee Star Farm Johanna Lad, Sir Korndyke Cornucopia, and many others.

From the above lines of breeding you will find all the high producing sires of the breed, with the exception of a small family which we shall designate as Admiral Walker, the sire of Walker Pietertje and the grandsire of King Walker.

In selecting herd sires for purebred or grade herds of Holstein-Friesians, where you desire high yearly production, it seems necessary that the pedigree should contain as many animals as is possible that are found in the lineage as presented in Table VI. It certainly is very forcibly brought out that the high producing cows come from certain definite lines of breeding, and that certain other lines of breeding are not

capable of producing daughters with high production, or at least they have not done so thus far.

The above tables represent the detailed study of 1478 animals, thus giving sufficient numbers to establish certain facts. It is from this list of sires and families that any breeder may expect to materially improve his herd, and should help breeders in selecting successful herd sires.

SUMMARY

Yearly records are the most reliable test of actual production.

Total number of Advanced Registry daughters does not always mean prepotency for high producing daughters. Popular sires are not always prepotent sires of high producing daughters.

A large number of high producing daughters, as compared with total number of daughters, is the important essential.

Well bred animals of good individuality are essential to successful breeding.

TABLE III: *List of Sires Having One or More Equivalent to 1000 Pound Butterfat Daughters*

Rank	Name of Sire	No. A. R. O. daughters	No. proven sons	No. daughters dams of tested daughters	No. equivalent to 1000 lb. daughters	No. equivalent to 800 lb. daughters	No. equivalent to 600 lb. daughters	Year of birth
1	King Segis Pontiac Count	29	8	4	5	12	13	1911
2	King Hengerveld Aaggie Fayne	34	4	16	3	4	5	1908
3	Sir Pietertje Ormsby Mercedes	68	23	14	2	16	42	1907
4	King of the Pontiacs	251	160	80	2	14	25	1905
5	Pontiac Aaggie Korndyke	58	21	21	2	9	13	1905
6	King Pontiac Champion	94	25	25	2	8	22	1908
7	Friend Hengerveld DeKol B. Boy	46	5	20	2	4	4	1901
8	Aaggie 3d's Wayne Paul DeKol	19	1	25	2	3	4	1900
9	Sir Veeman Hengerveld	103	13	53	1	6	8	1904
10	King Walker	67	25	25	1	5	10	1905
11	Colantha Johanna Lad	126	92	33	1	4	9	1903
12	King Mead of Riverside	24	1	6	1	3	13	1908
13	Prince Gelsche Walker	30	6	2	1	3	7	1910
14	Maplecrest Pontiac Hartog	26	4	4	1	3	4	1908
15	King Segis Beets	47	18	20	1	3	4	1906
16	Johanna Rue 3d's Lad	49	30	40	1	3	3	1899
17	Alcartra Polkadot Corrector	22	17	21	1	3	9	1902
18	Sir Korndyke Hengerveld DeKol	45	36	21	1	2	5	1905
19	Pontiac Korndyke	147	119	96	1	2	5	1898
20	Sir Johanna Canary DeKol	16	2	13	1	2	3	1906
21	King Beauty Pietertje DeKol	9	1	3	1	2	2	1907
22	Cornucopia Waukasha Prince	11	3	13	1	2	2	1904
23	McKinley Hengerveld DeKol	16	3	13	1	1	3	1907
24	Dutchland Sir Pietertje Hengerveld	23	13	5	1	1	3	1907
25	Pontiac Appollo	50	14	18	1	1	2	1905
26	Iowana Sir Ollie	2	0	0	1	1	2	1913
27	Sir Ormsby Skylark	11	1	8	1	1	2	1907
28	Ona Pontiac DeKol	1	0	0	1	1	1	1908
29	Flora Brank Paul Pledge	8	0	9	1	1	1	1903
30	Paul DeKol of Royalton	8	2	5	1	1	1	1903
31	Sir Hengerveld DeKol Abbekerk	11	0	0	1	1	1	1908
32	Linden Butter Boy Pietertje	9	0	6	1	1	1	1907
33	Butter Boy Segis Korndyke	17	0	5	1	1	1	1908
34	Sir Jolie Johanna 4th	5	0	2	1	1	1	1903
35	Sir Ormsby Burke Segis	21	1	10	1	1	1	1908
36	Admiral Urmagal Burke	4	0	0	1	1	1	1913
37	SeKol Beets Segis 4th	9	1	1	1	1	1	1910
38	Soldene Beets Butter Boy	1	0	0	1	1	1	1910
39	Sir Hengerveld Clyde	1	0	0	1	1	1	1912
40	Leda Hengerveld Sir Piebe	3	0	2	1	1	1	1904

TABLE IV: *List of Sires Having Two or More Equivalent to 800 Pound Butterfat Daughters*

Rank	Name of Sire	No. A. R. O. daughters	No. proven sons	No. daughters dams of tested daughters	No. equivalent to 1000 lb. daughters	No. equivalent to 800 lb. daughters	No. equivalent to 600 lb. daughters	Year of birth
1	Sir Pietertje Ormsby Mercedes	68	23	14	2	16	42	1907
2	King of the Pontiacs	251	160	80	2	14	25	1905
3	King Segis Pontiac Count	29	8	4	5	12	13	1911
4	Pontiac Aaggie Korndyke	58	21	21	2	9	13	1905
5	King Pontiac Champion	94	25	25	2	8	22	1908
6	Sir Johanna Piebe	25	9	12	0	7	14	1907
7	Sir Veeman Hengerveld	103	13	53	1	6	8	1904
8	Spring Farm King Pontiac 6th	49	3	0	0	6	8	1911
9	King Walker	67	25	28	1	5	10	1905
10	Pietertje Hengerveld Sir Korn	17	6	6	0	5	10	1909
11	Colantha Johanna Lad	126	92	55	1	4	9	1903
12	King Hengerveld Aaggie Fayne	30	4	16	3	4	5	1908
13	Friend Hengerveld DeKol B. Boy	46	45	20	2	4	4	1901
14	Masterpiece	17	1	6	0	4	4	1910
15	Aaggie 3d Wayne Paul DeKol	19	1	25	2	3	4	1900
16	King Mead of Riverside	24	1	6	1	3	13	1908
17	Maplecrest Pontiac Hartog	26	4	4	1	3	5	1908
18	Prince Gelsche Walker	30	6	2	1	3	7	1910
19	King Segis Beets	47	18	20	1	3	4	1906
20	Johanna Rue 3d's Lad	49	30	40	1	3	3	1899
21	Sir Hengerveld Model Johanna	20	9	13	0	3	9	1905
22	Sir Paul Veeman Hengerveld	16	0	3	0	3	8	1911
23	Juliana King of Riverside	16	9	14	0	3	7	1904
24	Sir Inka DeKol Chief	10	0	3	0	3	6	1907
25	Colantha Johanna Champion	55	27	0	3	3	5	1906
26	Woodcrest Pietje Walker	6	0	0	0	3	4	1912
27	Ormsby Korndyke Lad	31	4	4	0	3	4	1910
28	Johanna Beets	5	0	10	0	3	3	1909
29	Alcartra Polkadot Corrector	22	17	21	1	2	9	1902
30	Sir Korndyke Hengerveld DeKol	45	36	21	1	2	5	1905
31	Pontiac Korndyke	147	119	96	1	2	5	1898
32	Sir Johanna Canary DeKol	16	2	13	1	2	3	1906
33	King Beauty Pietertje DeKol	9	1	3	1	2	2	1907
34	Cornucopia Waukasha Prince	11	3	13	1	2	2	1904
35	Dutchland Colantha Sir Inka	69	12	37	0	2	14	1908
36	Ignaro DeKol	25	7	25	0	2	11	1897
37	Homestead Girl DeKol Sarc. Lad	107	45	63	0	2	8	1903
38	Quirinus Cornucopia	21	4	4	0	2	7	1907
39	Hygeia Veeman Butter Boy	12	1	6	0	2	6	1908
40	Admiral Walker Pietertje	60	16	38	0	2	6	1902
41	Sir Longfield DeKol	12	3	10	0	2	5	1904
42	Piebe Laura Ollie Homestead King	16	0	0	0	2	5	1913
43	Segis Pontiac DeKol Burke	24	3	0	0	2	5	1912
44	Cor-Will Colantha Paul DeKol	8	0	7	0	2	4	1907
45	King Pietertje Cloverdale	12	1	4	0	2	4	1910
46	Johanna de Pauline 2d's Lad	38	17	7	0	2	4	1900
47	Sir Fayne Concordia	27	27	22	0	2	4	1904
48	Judge Hengerveld DeKol	43	16	21	0	2	3	1906
49	Tidy Abbekerk Prince	91	16	50	0	2	3	1905
50	Cornucopia Pontiac Johanna Lad	19	2	4	0	2	3	1907
51	Sindt Butter Boy	22	5	4	0	2	3	1907
52	Walker Korndyke Segis	13	20	8	0	2	3	1907
53	Ononis Paul DeKol	4	0	5	0	2	2	1902
54	Wachusett Creamelle George	2	0	1	0	2	2	1906
55	King Segis Butter Boy	35	5	13	0	2	2	1905
56	Pontiac Hesseltje Korndyke	53	10	13	0	2	2	1903
57	Sir Korndyke Bess	8	0	0	0	2	2	1912
58	Sir Pietertje Ormsby Mercedes 14th	5	0	1	0	2	2	1911

TABLE V: *List of Sires Having Five or More Equivalent to 600 Pound Butterfat Daughters*

Rank	Name of Sire	No. A. R. O. daughters	No. proven sons	No. daughters dams of tested daughters	No. equivalent to 1000 lb. daughters	No. equivalent to 800 lb. daughters	No. equivalent to 600 lb. daughters	Year of birth
1	Sir Pietertje Ormsby Mercedes	68	23	14	2	16	42	1907
2	King of the Pontiacs	151	160	80	2	14	25	1905
3	King Pontiac Champion	94	25	25	2	8	22	1908
4	Dutchland Colantha Sir Inka	69	12	37	0	2	19	1908
5	Sir Johanna Fayne	49	8	16	0	1	17	1905
6	Sir Johanna Piebe	25	9	12	0	7	14	1907
7	King Segis Pontiac Count	29	8	4	5	12	13	1911
8	Pontiac Aaggie Korndyke	58	21	21	2	9	13	1905
9	King Meade of Riverside	24	1	6	1	3	13	1908
10	Johanna de Colantha Champion	28	10	11	0	0	12	1909
11	Ignaro DeKol	25	7	25	0	2	11	1897
12	King Walker	67	25	28	1	5	10	1905
13	Pietertje Hengerveld Sir Korn	17	6	6	0	5	10	1909
14	Aaggie Cornucopia Paul. Count 13th	22	1	12	0	1	10	1906
15	Woodcrest Tehee	16	0	2	0	1	10	1910
16	Colantha Johanna Lad	126	92	55	1	4	9	1903
17	Sir Hengerveld Model Johanna	20	9	13	0	3	9	1905
18	Alcartra Polkadot Corrector	22	17	21	1	2	9	1902
19	King Colantha Clothilde	29	24	11	0	0	9	1909
20	Emblagaard Tritomia Homestead	29	3	9	0	1	9	1909
21	Aggie Cornucopia Johanna Lad Jr.	61	34	28	0	0	9	1904
22	Sir Veeman Hengerveld	103	13	53	1	6	8	1904
23	Homestead Girl DeKol Sarc. Lad	107	45	63	0	2	8	1903
24	Spring Farm King Pontiac 6th	49	3	0	0	6	8	1911
25	Sir Paul Veeman Hengerveld	16	0	0	0	3	8	1911
26	King Segis Hengerveld Vale	13	4	2	0	0	8	1909
27	Prince Gelsche Walker	30	6	2	1	3	7	1910
28	Juliana King of Riverside	16	9	14	0	3	7	1904
29	Quirinus Cornucopia	21	4	4	0	2	7	1907
30	Star Farm Johanna Lad	14	3	2	0	0	7	1907
31	Sir Walker Segis	30	8	8	0	0	7	1907
32	Sir Inka DeKol Chief	10	0	3	0	3	6	1907
33	Hygeia Veeman Butter Boy	12	1	6	0	2	6	1906
34	Admiral Walker Pietertje	60	16	38	0	2	6	1902
35	Korndyke Queen DeKol Prince	90	25	61	0	1	6	1899
36	King Hengerveld Aaggie Fayne	30	4	16	3	4	5	1908
37	Maplecrest Pontiac Hartog	26	4	4	1	3	5	1908
38	Sir Korndyke Hengerveld DeKol	45	36	21	1	2	5	1905
39	Pontiac Korndyke	147	119	96	1	2	5	1898
40	Colantha Johanna Champion	55	27	20	0	3	5	1906
41	Sir Longfield DeKol	12	3	10	0	2	5	1904
42	Segis Pontiac DeKol Burke	24	3	0	0	2	5	1912
43	Piebe Laura Ollie Homestead King	16	0	0	0	2	5	1913
44	Piebe Champion	31	8	10	0	1	5	1908
45	King Palmyra Fayne	32	5	10	0	1	5	1910
46	Emblagaard Prince	21	1	5	0	0	5	1910
47	Canary Paul	27	22	13	0	0	5	1907
48	Paul Frenesta DeKol	47	2	10	0	0	5	1906
49	Butter Boy Sir Mechthilde	8	2	5	0	0	5	1904
50	Beauty Walker Pietertje King	26	1	10	0	0	5	1910
51	Pontiac Hengerveld Parthenea	84	30	52	0	0	5	1905
52	Pearl of the Dairy's Joe DeKol	76	10	59	0	0	5	1897

TABLE VI: *Genealogy Table*

Sir Henry of Maplewood (1–8–2*0–0–0)
1. Mechthilde Sir Henry of Maplewood (7–14–8*0–0–0)
1. Tirania's Sir Mechthilde (3–7–5*0–0-0)
Sir Abbekerk (0–0–0*0–0–0)
DeKol 2d Butter Boy (12–21–19*0–0–0)
1. Hengerveld DeKol (116–67–85*0–1–1)
1. Sir Korndyke Hengerveld DeKol (45–36–21*1–2–5)
1. King Korndyke Hengerveld Ormsby (60–18–10*0–0–0)
Ormsby Korndyke Lad (31–4–4*0–3–4)
2. Sir Korndyke Hengerveld DeKol 36th (8–6–0*0–0–2)
Sir Korndyke Bess (8–0–0*0–2–2)
2. Sir Hengerveld Model Johanna (20–9–13*1–1–3)
Sir Hengerveld Clyde (1–0–0*1–1–1)
3. Judge Hengerveld DeKol (43–16–21*0–2–3)
McKinley Hengerveld DeKol (16–3–13*1–1–3)
4. Woodcrest Nig DeKol (45–22–27*0–0–0)
Sir Hengerveld DeKol Abbekerk (11–0–0*1–1–1)
5. Pontiac Appollo (50–14–18*1–1–2)
6. Pontiac Hengerveld Parthenea (84–30–52*0–0–5)
2. DeKol Burke (78–48–61*0–1–1)
Piebe DeKol Burke (28–19–32*0–0–0)
1. Chief Piebe Oak Duchess (22–5–17*0–0–0)
Alcartra Polkadot Corrector (62–17–21*1–2–9)
2. Leda Hengerveld Sir Piebe (3–0–2*1–1–1)
3. Baron Pauline DeKol (13–2–11*0–0–0)
Sir Piebe DeKol (10–5–11*0–0–0)
Almeda Luecke 2nd's Piebe DeKol (7–15–8*0–0–0)
Sir Longfield DeKol (12–3–10*0–2–5)
4. Pietertje Hengerveld Count DeKol (99–59–69*0–0–0)
Dutchland Sir Pietertje Hengerveld (23–13–5*1–1–3)
2. Empress Josephine 3d Sir Mechthilde (3–8–10*0–0–0)
Manor Josephine DeKol (6–5–4*–0–0–0)
Pontiac Korndyke (147–119–96*1–2–5)
1. King of the Pontiacs (251–160–80*2–14–25)
1. King Pontiac Champion (94–25–25*2–8–22)
2. Spring Farm King Pontiac (39–24–5*0–0–3)
Spring Farm King Pontiac 6th (49–3–0*0–6–8)
3. Cornucopia Pontiac Johanna Lad (19–2–4*0–2–3)
2. Pontiac Aaggie Korndyke (58–21–21*2–9–13)
Maplecrest Pontiac Hartog (26–4–4*1–3–4)
Ona Pontiac DeKol (1–0–0*1–1–1)
3. Pontiac Hesseltje Korndyke (53–10–33*0–2–2)
2. Sir Mechthilde of Maplewood (2–3–2*0–0–0)
Mercedes Mechthilde Pietertje (8–22–11*0–0–0)
Jack Mercedes (6–2–7*0–0–1)
Sir Pietertje Ormsby Mercedes (68–23–14*2–16–42)
Sir Pietertje Ormsby Mercedes 14th (5–0–1*0–2–2)
Neptune Jr. (0–0–0*0–0–0)
DeKol 2d Prince (0–0–0*0–0–0)
Paul DeKol (38–25–29*0–0–0)
1. Paul Mutual DeKol (3–8–6*0–0–0)
1. Johanna Rue 2d's Paul DeKol (33–14–33*0–0–0)
Mercedes Julip's Pietertje Paul (89–36–53*0–0–0)
King Segis (87–85–60*0–0–0)
1. King Segis Pontiac (122–59–29*0–1–1)
1. Butter Boy Segis Korndyke (17–0–5*1–1–1)
2. King Segis Pontiac Count (29–8–4*5–12–13)
3. King Segis Pontiac Emperor (11–7–3*0–0–1)
Segis Pontiac DeKol Burke (24–3–0*0–2–5)
2. King Segis Beets (47–18–20*1–3–4)
3. King Fayne Segis (28–27–19*0–0–0)
1. Masterpiece (17–1–6*0–4–4)
2. King Hengerveld Aaggie Fayne (30–4–16*3–4–5)
3. King Palmyra Fayne (32–5–10*0–1–5)
4. King Segis Butter Boy (35–5–13*0–2–2)
5. King Segis Hengerveld Vale (13–4–2*0–0–8)

TABLE VI: *Genealogy Table—(Continued)*

6. Sir Ormsby Burke Segis (21–1–10*1–1–1)
7. Sir Walker Segis (30–8–8*–0–0–7)
8. Walker Korndyke Segis (13–20–8*0–2–3)
9. DeKol Beets Segis (35–13–24*0–0–3)
DeKol Beets Segis 4th (9–1–1*1–1–1)

2. Paul Johanna DeKol (5–3–9*0–0–0)
Pearl of the Dairy's Joe DeKol (76–10–59*0–0–5)
3. Paul DeKol Clothilde (12–3–2*0–0–0)
Johanna 5th Paul DeKol (1–3–4*0–0–0)
Ignaro DeKol (25–7–25*0–2–11)
4. Johanna Rue 2d Paul DeKol (33–14–33*0–0–2)
Canary Mercedes Johanna DeKol (16–9–12*0–0–0)
Inka Clothilde Mercedes Prince (17–7–16*0–0–1)
Sir Inka DeKol Chief (10–0–3*0–3–6)

2. Count Paul DeKol (8–11–13*0–0–0)
1. Pauline Paul's 2d Count (20–16–17*0–0–0)
Aaggie Cornucopia Pauline Count (90–49–39*0–0–0)
1. Aaggie Cornucopia Pauline Count Jr. (7–3–9*0–1–1)
2. Cornucopia Waukasha Prince (11–3–13*1–2–2)
3. Aaggie Cornucopia Pauline Count 13th (22–1–12*0–1–10)
2. A & G Paul DeKol Butter Boy (9–2–10*0–0–0)
Fidessa Butter Boy (7–6–7*0–0–1)
Juliana King of Riverside (16–9–14*0–3–7)
King Mead of Riverside (24–1–6*1–3–13)

3. Paul DeKol Jr. (23–25–21*0–1–1)
1. Homestead Jr. DeKol (73–39–71*0–0–2)
1. Sir Fayne Concordia (27–27–22*0–2–4)
1. Sir Johanna Ruth (32–5–16*0–0–0)
Sir Johanna Piebe (25–9–12*0–7–14)
2. Sir Johanna Fayne (49–8–16*0–1–17)
3. Colantha Johanna Champion (55–27–20*0–3–5)
1. Johanna de Colantha Champion (28–10–11*0–0–12)
2. Piebe Champion (31–8–10*0–1–5)
2. Emblagaard Tritomia Homestead (29–3–9*0–1–9)
2. Homestead Hengerveld DeKol Paul (29–12–31*0–0–0)
Ononis DeKol Paul (4–0–5*0–2–2)

4. Mutual Friend 3d's Paul (17–25–19*0–0–0)
1. Flora Brank's Mutual Friend Paul (10–7–14*0–0–0)
Flora Brank Paul Pledge (8–0–9*1–1–1)
2. DeKol 2d Mutual Paul (49–40–36*0–1–2)
1. Mutual Pietertje Paul (30–22–15*0–1–1)
Paul Frenesta DeKol (47–2–10*0–0–5)
2. Mooie Mutual DeKol (35–20–33*0–0–0)
Fobes Tritomia Mutual DeKol (38–31–26*0–0–2)
Oak DeKol 2d Homestead Fobes (12–7–4*0–0–2)
Oak DeKol Ollie Homestead (15–3–3*0–1–3)
Piebe Laura Ollie Homestead King (16–0–0*0–2–5)

5. Paul DeKol 3d (13–12–17*0–0–0)
1. Aaggie 3d's Wayne Paul DeKol (19–1–25*2–3–4)
2. Sir Veeman Hengerveld (103–13–53*1–6–8)
Sir Paul Veeman Hengerveld (16–0–0*0–3–8)

6. Nelly Grant 4th Paul DeKol (20–1–67*0–0–0)
Sir Paul DeKol Clothilde (4–2–2*0–0–0)
Calamity Jane's Paul (18–20–16*0–0–0)
Calamity Jane's Paul A (29–9–31*0–0–0)
Canary Mercedes Paul (28–14–25*0–0–4)
Sir Johanna Canary DeKol (16–2–11*1–2–3)
Ononis DeKol Paul (4–0–5*0–2–2)

7. DeKol 2d Paul DeKol (45–37–35*0–0–0)
Pietertje Hengerveld's Paul DeKol (16–30–14*0–0–0)
1. Gem Pietertje Paul DeKol (25–16–27*0–0–0)
Sir Ormsby Hengerveld DeKol (69–26–42*0–1–4)
Sir Ormsby Skylark (11–1–8*1–1–2)
2. Canary Paul (27–22–13*0–0–5)
Canary Paul Fobes Homestead (46–28–16*0–0–2)
Iowana Sir Ollie (2–0–0*1–1–2)

TABLE VI *Genealogy Table—(Concluded)*

Netherland Prince (0–0–0*0–0–0)
1. Netherland Alban (1–3–5*0–0–0)
DeKol 2d Netherland (22–21–29*0–0–0)
Manor DeKol (34–25–28*0–0–0)
1. Lorraine Prince (0–0–0*0–0–0)
Korndyke Queen DeKol's Prince (90–25–61*0–1–6)
2. DeKol 2nd Butter Boy 3d (119–95–87*0–1–4)
1. Friend Hengerveld DeKol Butter Boy (46–45–20*2–4–4)
2. Sir Korndyke Manor DeKol (51–43–28*0–0–0)
Faforit Tritomia Sir Korndyke (10–10–7*0–0–0)
Pietertje Hengerveld Sir Korndyke (17–6–6*0–5–10)
3. Hygeia Veeman Butter Boy (12–1–6*0–2–6)
4. Butter Boy Pietertje (47–30–44*0–0–1)
1. Linden Butter Boy Pietertje (9–0–6*1–1–1)
2. Butter Boy Sir Mechthilde (8–2–5*0–0–5)
5. Creamelle DeKol Butter Boy (10–7–6*0–0–0)
Wachusett Creamelle George (2–0–1*0–2–2)
6. DeKol Hengerveld Burke (39–32–28*0–0–0)
Sir Urmagal Burke (53–9–17*0–1–2)
Admiral Urmagal Burke (4–0–0*1–1–1)
7. Pontiac Soldene Butter Boy (6–3–4*0–0–0)
Soldene Beets Butter Boy (1–0–0*1–1–1)
2. Netherland Statesman (0–0–0*0–0–0)
Clothilde 3d's Netherland (1–3–7*0–0–0)
Maurice Clothilde (1–3–6*0–0–0)
Maurice Bonheur (3–2–8*0–0–0)
Sarcastic Lad (34–38–27*0–0–0)
1. Johanna Aaggie Sarcastic Lad (18–25–28*0–0–0)
1. Homestead Girl DeKol Sarcastic Lad (107–45–63*0–2–8)
1. Woodcrest Tehee (16–0–2*0–1–10)
2. Star Farm Johanna Lad (14–3–2*0–0–7)
3. Pietje 22nd Son (32–8–7*0–0–4)
Woodcrest Pietje Walker (6–0–0*0–3–4)
2. Aaggie Cornucopia Johanna Lad (107–76–86*0–1–1)
1. Sir Tehee Cornucopia (31–7–15*0–0–0)
Quirinus Cornucopia (21–4–4*0–2–7)
2. Johanna Beets (5–0–10*0–3–3)
3. Aaggie Cornucopia Johanna Lad Jr. (61–34–28*0–0–9)
2. Colantha Johanna Lad (126–92–55*1–4–9)
1. Dutchland Colantha Sir Inka (69–12–37*0–2–19)
2. King Colantha Clothilde (29–24–11*0–0–0)
1. Emblagaard Prince (21–1–5*0–0–5)
2. Beauty Walker Pietertje King (26–1–10*0–0–5)
3. Johanna Rue 3d's Lad (49–30–40*1–3–3)
4. Johanna de Pauline 2nd's Lad (38–13–37*0–2–4)
5. Colantha 4th's Lad (25–21–21*0–0–3)
Gerben's Colantha Lad (16–3–3*0–0–0)
Cor-Will Colantha Paul DeKol (8–0–7*0–2–4)
6. Johanna DeKol's Lad (33–6–18*0–0–0)
Johanna DeKol 2d's Lad (20–13–25*0–0–0)
Sir Jolie Johanna (19–5–9*0–0–1)
Sir Jolie Johanna 4th (5–0–2*1–1–1)

Dam by Paul DeKol (38–25–29*0–0–0)
Pauline Paul of Portage DeKol (2–6–5*0–0–0)
Paul DeKol of Royalton (8–2–5*1–1–1)

Admiral Walker (6–4–6*0–0–1)
Admiral Walker Pietertje (60–16–38*0–2–6)
1. King Walker (67–25–28*1–5–10)
2. Admiral Walker Gelsche (49–16–17*0–0–0)
Dam of Prince Gelsche Walker (30–6–2*1–3–7)
by Admiral Walker Gelsche

King Pietertje Cloverdale (12–1–4*0–2–4)
Great grandson of DeKol 2d's Paul DeKol and Sarcastic Lad

Tidy Abbekerk Prince (91–16–50*0–2–3)
and
King Beauty Pietertje DeKol (9–1–3*1–2–2)
Trace in the 4th generation to Mechthilde Sir Henry of Maplewood

- King Segis Pontiac, 44444 (122-59-29)
  - King Segis, 36168 (87–85–60)
    - Mercedes Julip's Pietertje Paul, 29830 (89–36–53)
      - Johanna Rue 3d's Paul De Kol, 21724 (33–14–32)
      - Mercedes Julip's Pietertje 39480 29.36 lb. butter.
    - & G. Inka McKinley 55163 29.62 lb. butter
      - Billy McKinley, 23378 (5–2–4)
      - Segis Inka, 36617 28.04 lb. butter
  - Pontiac Clothilde De Kol 2d, 69991 12.71 lb. butter
    - Pontiac Korndyke 25982 (147–119-96)
      - Manor Josephine De Kol, 22779 (6–5–4)
      - Belle Korndyke, 13913 25.77 lb. butter.
    - Pontiac Clothilde De Kol, 49657 23.11 lb. butter
      - Hengerveld De Kol, 23102 (116–67–85)
      - Rag Apple's Clothilde Artis, 34741 12.53 lb. butter
- King Segis Pontiac Count, 93909 (25–8–4)
- K. P. Lilith Clothilde 110228 1043 lb. butter
  - King of the Pontiacs, 39037 (251–160–80)
    - Pontiac Korndyke, 25982 (147–119–96)
      - Manor Josephine De Kol, 22779 (6–5–4)
      - Belle Korndyke, 13913 25.77 lb. butter
    - Pontiac Lunde Hengerveld, 51585 28.41 lb. butter
      - Hengerveld De Kol, 23102 (116–67–85)
      - Lunde Beauty, 34745 11.84 lb. butter
  - Lilith Clothilde
    - Lilith Pauline De Kol's Count, 28430 (95–56–74)
      - Pauline Paul 2d's Count, 22902 (20–16–17)
      - Lilith Pauline De Kol, 43434 28.24 lb. butter
    - Clothilde Pietertje Boon, 61391
      - Lamb De Kol Pietertje Boon, 27347 (1–0–5)
      - Maggie Lamb, 39025
- Sir Pietertje Ormsby Mercedes (68–23–14)
- Jack Mercedes, 35077 (6–2–7)
  - Mercedes Mechthilde Pietertje, 25795 (8–22–11)
    - Sir Mechthilde of Maplewood, 23448 (2–3–2)
      - Sir Henry of Maplewood (1–8–2)
      - Lady Aaggie Flora
    - Mercedes Julip's Pietertje, 39480 29.36 lb. butter
      - Elaine's Pietertje 20854 (1–0–1)
      - Mercedes Julip
  - Sadie Mechthilde, 60968
    - Chief Josephine Mechthilde, 26483 (1–3–4)
      - Second Sir Josephine Mechthilde, 24478 (2–3–2)
      - Beechwood Bessie (32 W.H.F.A.)
    - Aaltje Maid, 51525
      - Sir Aaggie Colantha, 24412
      - Winnebago Belle (1200 W.H.F.A.)
- Pietertje Maid Ormsby, 78051 35.56 lb. butter
  - Sir Ormsby Hengerveld De Kol, 31212 (69–26–42)
    - Gem Pietertje Hengerveld's Paul De Kol, 23300 (25–16–27)
      - Pietertje Hengerveld's Paul De Kol 16–30–14
      - Maplecroft Gem, 35909 20.10 lb. butter
    - Duchess Ormsby 2d, 35439 21.31 lb. butter
      - Tritomia Netherland Carl, 16406 (7–2–16)
      - Duchess Ormsby
  - Pietertje Maid of Grouw 3d, 53646 18.45-lb. butter
    - De Kol 2d Paul DeKol No. 2, 23366
      - Paul De Kol (38–25–29)
      - May Hartog of Brookside
    - Pietertje Maid of Grouw, 42832 13.00 lb. butter
      - Jeltje S. Netherland's Pietertje, 15927 (7–3–7)
      - Maid Mercedes of Grouw